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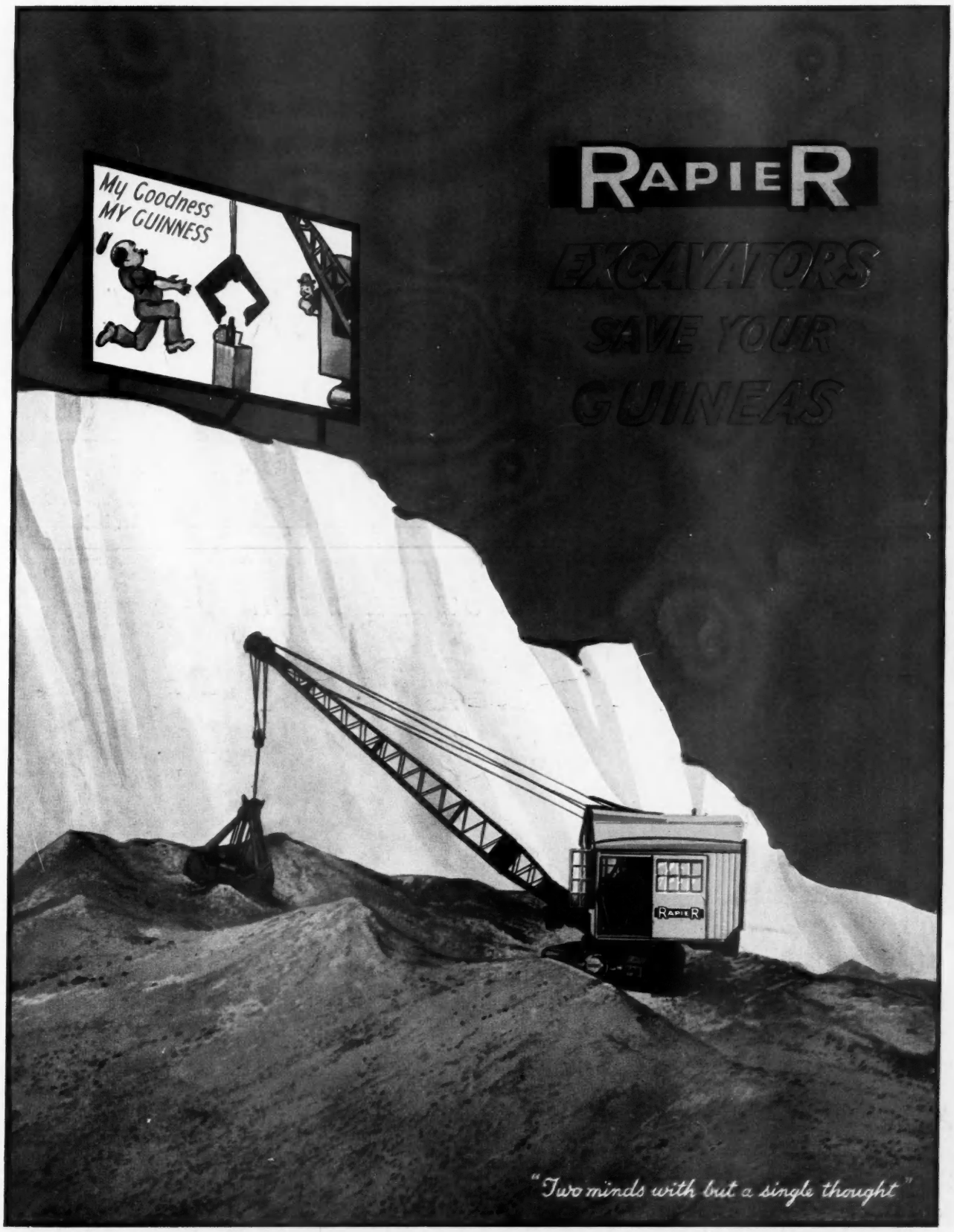

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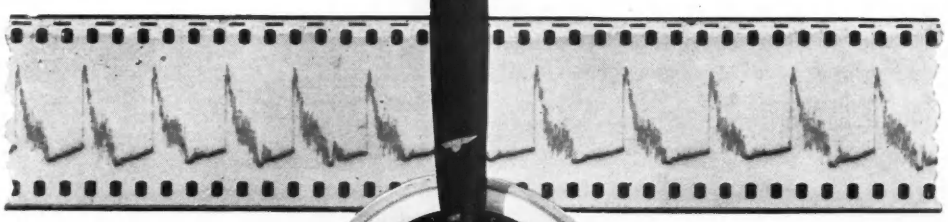

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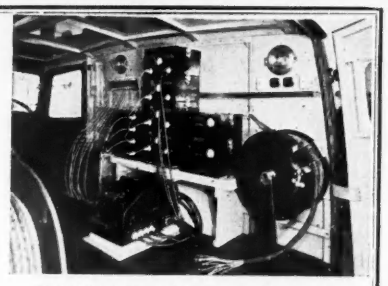

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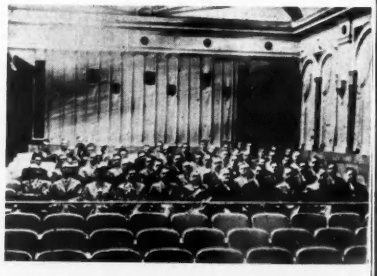

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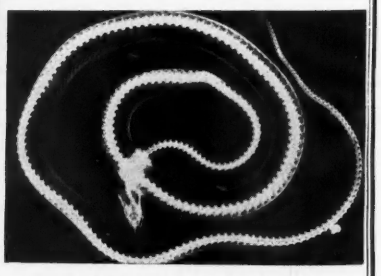

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A Seven-Day Journal

Purchases from America

THE Government has decided to set up a Central Organisation to be known as the "British Supply Board in Canada and the United States," for the purpose of co-ordinating purchases in the two countries. Colonel J. H. M. Greenly has been appointed Controller-General and Chairman, with Sir James Rae as Deputy Controller-General and Vice-Chairman. The Board will place orders in Canada through the Canadian War Supply Board recently set up by the Canadian Government under the chairmanship of Mr. Wallace Campbell. Orders in the United States will be placed through a British Purchasing Commission under the charge of Mr. Arthur B. Purvis, who has been appointed Director-General of Purchases (United States). Mr. Wallace Campbell and Mr. Purvis will be members of the central organisation which will also include representatives of the British Service Departments and His Majesty's Treasury. The personnel of the present British Purchasing Mission in Canada will be merged in the new organisation. A later announcement, we learn, will be made regarding the necessary arrangements to secure close co-ordination of British and French purchases in the United States.

The Trade Union Advisory Committee

THE first Meeting of the Trade Union Advisory Committee to the Ministry of Supply was held in the Ministry of Supply, The Adelphi, London, on the afternoon of November 17th. The Meeting was presided over by the Minister of Supply, Mr. E. L. Burgin, and the members of the Committee attending it were: Mr. W. Holmes, Mr. E. Bevin, Mr. J. Brown, Mr. H. Bullock, Mr. A. Conley, Sir Walter Citrine, Mr. J. Hallsworth, Mr. M. Hodgson, Mr. K. Taylor, Mr. F. Wolstencroft, and Mr. E. P. Harries. The Minister of Supply was accompanied by Colonel J. J. Llewellin, M.P., Parliamentary Secretary to the Ministry, Vice-Admiral Sir Harold Brown, and Mr. O. S. Cleverly. A general discussion took place on ways and means of assisting the production programme. Among specific questions mentioned was the full constitution of the area organisation of the Ministry. The Meeting was informal and cordial in character, and a large measure of agreement was reached on all points discussed.

Ministry of Supply Displays

To assist firms not now engaged in munition production, the Ministry of Supply has arranged that samples of munition stores, with approximate prices, shall be displayed at Newcastle-on-Tyne, Sheffield, Nottingham, Cambridge, Tunbridge Wells, Bristol, Birmingham, Manchester, and Glasgow, as from Monday, November 13th. Applications to examine the samples should be made to the Area Officers of the Ministry of Supply, who will issue a card of admission which will indicate the address at which the samples can be seen. A display of the same samples will be available in London towards the end of November, and applications to view them should be made to the Area Officer, Savoy Hill House, Savoy Hill, W.C.2, who will also arrange for samples to be seen at Tunbridge Wells.

The Cymmer Colliery, Porth

THE famous Cymmer Colliery at Porth, Glamorganshire, from which coal was raised for over a hundred years, recently ceased work. The immense quantity of plant which it contains is to be dismantled and made available for use either in the coal industry or for others engaged on contracts of National importance. The work of dismantling and disposing of the plant is in the hands of George Cohen, Sons and Co., Ltd., which has already brought 600 tons of machinery to the surface. The history of this colliery, which once employed over 3000 men and produced over 3000 tons of coal a day, is interesting. The first pit was sunk more than a century ago to a depth of only 45ft., and it was worked by an old beam engine with timber head-gear, some examples of which still exist at one or two Cornish clay-pits. The shaft was rectangular in shape. Some twenty-five years later the pit was deepened to reach another seam at 300ft., and a few years later, to yet another seam at 390ft. Somewhere about 1860 a second shaft was sunk, and this shaft is still working to-day as the upcast. After ten years' work in this second pit there was a serious explosion, as a result of which about sixty men were killed. Later this pit was sunk to 450ft., its present depth. In the 1880's a third shaft was sunk, but this time to 1290ft. deep. About fifty years ago, whilst boring in this shaft for piping supports the men struck a "glas blower" or pocket of free gas. In those days men were permitted to take naked lights down in the cage with them to the pit bottom, so that they could heat their tea, and one of these lights ignited the natural gas. It was obviously dangerous to allow the gas to escape into the shaft, and accordingly a 2in. pipe line was installed to conduct it to the surface. Here it has been burning for fifty years without being extinguished. A measurement was taken of the "blow," and it was found that approximately 650ft. per hour was being emitted. The gas is chiefly methane, and arrangements have now been made to bottle it in steel cylinders at about 800 lb. per square inch pressure for scientific and industrial use. Output at the colliery was at its peak between 1912–1921, notably during the last war, when both house and steam coal were produced. In 1928 the production of house coal ceased and the men employed were reduced to 1400. This number remained in employment until this year, when it became obvious that the more economic seams had been worked out. At that time they extended for more than a mile-and-a-half underground, but during the long life of the colliery a much greater distance has been tunnelled.

Economics and the War

IN a lecture delivered before the Royal Philosophical Society at Glasgow last week, Professor G. Findlay Shirras in comparing the economic and financial strength of Great Britain with that of Germany had some interesting remarks to make regarding the activities of the Ministry of Supply. The war potential of this country, he said, would depend on the rapidity with which it switched over to a controlled economy for the production of war materials and of those goods required by our export trade which paid for imports. As the war progressed the Ministry of Supply was likely to become the most comprehensive trading organisation in the world. Constructive and vigorous executive action rather than control would be very necessary in order that even the smallest firms should be turned over to war work. That required economic planning. The time was coming when the Ministry's policy must become positive rather than negative. Speed was particularly necessary in obtaining raw materials, in the issue of licences and in carrying out contracts and co-ordinating controls. We ought to aim at drawing on our overseas assets as little as possible and to do that it was necessary to stimulate our export trade. That, it seemed clear to him, meant the regimentation of industry and a controlled economy. Control was important particularly when competing claims needed to be settled. In paying a tribute to Lord Stamp, who has an official status as adviser on economic co-operation but no seat in the Cabinet, he considered it unfortunate that the economic interests of the country and the economic strategy of the war could not be represented in the Cabinet.

Recent Appointments

IT was announced on November 13th that the King has been pleased to approve the appointment of Sir Arthur Salter as Parliamentary Secretary to the Ministry of Shipping. In the last war Sir Arthur held successive responsible posts concerned with shipping problems. He was Assistant Director of Transports at the Admiralty from 1915 to 1917, and was subsequently appointed Director of Ship Requisitioning at the Ministry of Shipping. Later he became Secretary of the Allied Maritime Transport Council and then Chairman of the Allied Maritime Transport Executive. The introduction of the convoy system received his support. In the debate on the state of the Mercantile Marine in the House of Commons last Tuesday he supported Sir John Gilmour representing the Ministry of Shipping. In reply to criticisms Sir John stated that the productive capacity of all shipbuilding yards in this country would be utilized and indicated the probability that orders would be given for shipbuilding in Canada. Mr. R. Hugh Roberts has been appointed Deputy Director-General of Equipment and Stores in the department of the Ministry of Supply, of which Lord Woolton is Director-General. Mr. Roberts, it is understood, has undertaken to serve in an advisory capacity. He is a member of the Grand Council of the Federation of British Industries, industrial adviser to H.M. Commissioner to the Special Areas, and Chairman of Fisher and Ludlow, Ltd., the Birmingham Guild, Ltd., and other companies.

Railway Matters

ON Thursday, November 9th, the Minister of Transport paid a visit to the goods and parcels depots of the Great Western Railway at Paddington, and the marshalling yard at Acton, at the invitation of the Railway Executive Committee. Commenting on what he had seen the Minister remarked that more wagons were now being handled at Acton than in times of peace, despite the fact that there was a decrease in the number during "black-out" hours. Experiments had shown that it was possible to improve the lighting in some marshalling yards, but each yard required separate consideration, and tests always had to be made in co-operation with aircraft. Some time must also necessarily elapse before special lighting equipment could be obtained and fixed. Since the outbreak of war the railways had been called upon to convey increased tonnages of goods quite apart from the quantities of naval and military stores and equipment, the carriage of which to the ports involved the running of hundreds of special trains. Owing to the difficulties of keeping this traffic moving in the "black-out" a number of freight trains had to be run in daytime, with the necessary consequence that there was an adverse effect upon passenger train services. Two other matters of interest regarding the railways occurred last week. The London, Midland and Scottish Railway announced that a scheme for the lighting of suburban trains had been approved by the authorities, and that the adaptation of passenger vehicles is now being proceeded with. It will be remembered that already a number of main-line corridor coaches on all railways have been fitted with better lighting. The problem of lighting suburban stock is, however, more complicated, owing principally to the greater number of doors. At the end of last week the National Union of Railwaymen accepted a majority finding of the Railway Staff National Tribunal on the application of the railway unions for higher wages and improved conditions of work. The application of the findings will cost the railways directly £660,000 a year, and consequential advances to bring the conditions of other men into due relation will lift the total cost above £1,000,000. The report of the Ministry of Transport Inspector, Col. A. C. Trench, into the de-railment of an express train from Glasgow Central to Ardrossan on August 5th was issued last Monday. It indicates that the de-railment occurred primarily as a result of a stone or stones having been placed on the track, and that no share of blame should be attributed to the train's crew. There was evidence of a considerable amount of trespassing on the track at the place of the accident.

Employment Statistics

ACCORDING to an announcement by the Ministry of Labour and National Service the numbers of unemployed persons on the registers of employment exchanges in Great Britain at October 16th, 1939, were 1,221,655 wholly unemployed, 146,451 temporarily stopped, and 62,532 normally in casual employment, making a total of 1,430,638. This was 99,710 more than the number on the registers at September 12th, 1939, but 350,589 less than at October 17th, 1938. The total on October 16th, 1939, consisted of 903,127 men, 43,920 boys, 417,798 women, and 65,793 girls. The greater increases in unemployment appear to have occurred in the London, the South Eastern, and Southern areas, the figures for which, as compared with the previous month, show increases of 54,840, 13,736, and 12,328 respectively, accounting for about 70 per cent. of the increase for the whole country. There were reductions in unemployment in the Midlands and North Midlands regions, but all other sections show increases as compared with last month. In coal-mining there has occurred a reduction of unemployment of 12,218 as compared with September, 1939, and of no less than 57,441 compared with a year ago. Unemployment in nearly all industries has decreased substantially as compared with October, 1938, but between September and October there were increases in public works contracting (10,957), road transport (9639), dock and harbour service (5735), and the distributive trades (20,164) amongst others. Some of these changes can no doubt be traced to the disturbing effect of war.

Automatic Train Control on the G.W.R.

THE Great Western Railway Company announces that with the fitting of the last ramp at Penzance on Thursday, November 9th, the scheme of installing its own system of automatic train control throughout the 2852 miles of main line routes between Paddington and Penzance, Fishguard, and Chester has been completed. The system was invented by members of the G.W.R. staff. It enables the engine driver to receive an audible warning in his cab as to the position of each caution signal about to be passed. If the line is clear a bell rings by the driver's side, but if it is not clear the signal is at caution, a siren blows, and the brakes are automatically applied throughout the train. Tests have proved that at 60 m.p.h. a train can be brought smoothly and automatically to a standstill in 900 yards or 450 yards before reaching the "stop" signal. The cost of carrying out the scheme is in the region of £250,000, and has necessitated the fitting of 3250 engines and installing 2114 ramps to the track.

Scottish Locomotive Experiences

By E. H. LIVESAY

No. VIII (Part II)—THE "CORONATION SCOT," L.M.S.R.—GLASGOW TO LONDON

(*Continued from page 469, Nov. 10th*)

Carlisle to London

THE following day, I continued the journey south on No. 6229, "Duchess of Hamilton," the enginemen being Driver Copperwheat and Fireman Tonner, my friends Curran and Gilbertson giving me a good send-off, after performing introductory ceremonies. The "Coronation Scot" pulled out at 3.19 p.m., 2 mins. late. The long and heavy incline up to Shap summit, 31·4 miles distant, begins almost at once on leaving Carlisle, the first part being 1 in 131; it was tackled with full open regulator, and a cut-off of 25 per cent. Wreay, 5 miles, was passed in 7½ mins., at 50 m.p.h., so acceleration was rapid up this quite considerable gradient. The load was the same as had been the case the day before, 300 tons, and as the speed-indicator was working, all the figures from Carlisle to London are taken from it. From Glasgow to Carlisle they are merely the enginemen's and my approximations, which, nevertheless, are close enough to reality. The next note I find in my pad refers to the riding: it is brief and to the point—"Good." At Calthwaite, 11 miles, still on a stiff rise, the speed had reached 60 m.p.h., and the cut-off had come back to 20 per cent.; passing Plumpton, two miles farther, on the level, we were doing 67 m.p.h. At Penrith, 18 miles, there was a signal check that brought us down to 50 m.p.h., notwithstanding which the station was passed at 3.39 p.m., only a minute late. We were getting back on to working schedule. Three miles farther on, a severe 8 miles pull at 1 in 125–142 begins, continuing nearly to Shap, but the cut-off remained at 20 per cent., and the speed at 50–55 m.p.h., the station being passed at 3.52 p.m. I began to watch out for the summit board, but a dawdling goods train interposed its trucks at the critical moment, and I missed it altogether. I have since been told that there is'nt one. The time, however, must have been approximately 3.54½ p.m., so the very heavy 31·4 miles from Carlisle had been covered in 35½ mins., giving an average speed of 53 m.p.h.; good going under the circumstances.

Over the top, the track drops very sharply for four miles at 1 in 75, and the speed rose quickly; we passed Scout Green Box doing 75 m.p.h., and Tebay at 3.59 p.m., 1 min. late, slowing a little for Dillicar troughs, which lie just beyond the station.

Grayrigg, 43 miles, is at the top of a 19 miles descent nearly to Carnforth; the station was passed at 4.04½ p.m., speed 60 m.p.h. It was 70 m.p.h. through Oxenholme, with 20 per cent. cut-off, and the regulator only slightly open. At Milnthorpe, speed was suddenly reduced to 15 m.p.h. for a permanent way restriction, but it soon picked up again, and we ran through Carnforth, 63 miles, at 70 m.p.h., the time being 4.23 p.m.; once more, as at the start, we were 2 mins. late. Carnforth roughly marks the dividing line between the very heavy northern section of the route, and the really easy succeeding 236 miles to London. There are no gradients worth bothering about over this latter stretch, at any rate when a powerful engine heads a 300 ton train. The average speed from Carlisle over Shap to Carnforth, 63 miles, had been 59 m.p.h.

Hest Bank troughs utilised, Lancaster was the next important point on the route; it was passed at 4.28 p.m., and we were still 2 mins. in the red there. The speed on the level through Bay Horse was 73 m.p.h., at Barton—after a slight reduction over Brock troughs—it was 75 m.p.h. This stretch is practically level, and I gave several glances at the indicator to note what was being done along it, until I realised it was unnecessary, our rate of travel being so consistently in the 70's. The sharply curved station at Preston, 90 miles from Carlisle, was negotiated cautiously at 4.47 p.m.; Copperwheat had evidently not yet begun to take steps to eliminate those two superfluous minutes.

After leaving Preston, the inclination is upward for several miles to Coppull, but is not sufficiently steep to affect the speed seriously. Between Farington and Leyland, on this stretch, the down "Coronation Scot" passed at high speed, yet there was little air-disturbance between the two trains; the streamlining was responsible for this. By this time, the front part of the bunker was getting denuded of coal, as "No. 6229" had come through from Glasgow, over 200 miles, and Tonner got the coal-pusher going. I am all in favour of this device; there was no need on this trip for me to get into the coal-space and do some work, as had been the case on the "Mid-day Scot" run. Wigan, 105 miles, was passed at 5.04 p.m., Warrington at 5.17 p.m.—3 mins. late now—and nearing Winsford, on a slight up gradient, the indicator showed 78 m.p.h. The riding at this speed was unexceptionable, though not quite up to the standard of that unforgettable L.N.E.R. 2–6–2, "No. 4793"! Nothing will ever come up to her, I am positive; I still ponder over the perfection of that locomotive Rolls-Royce. At Crewe the time was 5.38½ p.m.; 141 miles from Carlisle in 139½ mins., average speed 60·7 m.p.h., but we were still 2½ mins. behind the schedule.

It is very interesting to watch the "teamwork" of a good crew on the footplate, and after Crewe I did so, in the absence of anything else very important to record. There is seldom need for talk between "top link" men; an hour can easily pass without the interchange of a word. The enginemen know their jobs, and the work goes on in silence, in mutual confidence of each other's efficiency. When a curve obscured the early sighting of a signal by Copperwheat, Tonner was always on the watch for it from his side. As a rule nothing was said even then; Copperwheat would have his eye on his mate, and the needed warning would be given by a backward-raised hand if the signal was "on"—the flick of a finger if it was "off." Tonner seldom had time to sit down, though he admitted that the "Coronation Scot" is not a hard turn; its five-hour nonstop operation is the chief feature of stress. He was always ready to chat with me between spells of firing; I get most of my information en route from the fireman, as I have made it a cardinal rule to avoid distracting the driver's attention in any way, by questions, or least of all by conversation. "Do not speak to the man at the wheel" is a good motto for a third party on the footplate. The man behind the shovel comes into a different category, and can be looked on as more safely approachable.

Stafford, 165½ miles from Carlisle, was passed at 6.02 p.m., and I began to wonder when Copperwheat was going to set about recovering those errant minutes. Evidently he decided to do so somewhat about this time, as "No. 6229" accelerated, and after Rugeley I was giving more attention to the speed-indicator, as the schedule calls for an average of 80 m.p.h. to Lichfield. But this high figure was not quite reached, if the indicator could be relied on, though for several miles the needle stayed near it, and I began to make bets with myself—only myself, fortunately—that it would reach, and pass the 80 m.p.h. line. I lost—it stayed behind the desired mark, and we were still running a little late. Nevertheless, we were travelling faster than over any considerable stretch since leaving Glasgow, and high speed was kept up for many miles, except for a speed restriction near Atherstone. I felt certain we must at last be getting back on to schedule, and sure enough, Nuneaton was passed at 6.32 p.m.; we were dead on time.

From Whitmore troughs to Euston is 148 miles, and there are no gradients of any importance over this whole stretch, with the exception of the seven mile rise to Tring, and that is only 1 in 333. Things were naturally quite unruffled on the footplate, and as the miles rolled away behind us, the tranquillity in the cab, which almost verged on monotony, lent emphasis to the exaggerated absurdity of the descriptions of footplate methods and engine handling that sometimes appear in the lay press. From these one gathers the impression that express drivers handle their engines much as the skipper of a racing yacht nurses his craft in a fluky breeze. A picture is presented of a tense and highly-strung driving wizard, constantly on the *qui vive* to anticipate every change in gradient, playing fantasias on the regulator and cut-off scale, going into mental huddles in deciding whether 18 per cent. or 19 per cent. valve-travel would be best for a 1 in 250 incline—maybe 18·5 per cent. would be advisable? Borrowing Fireman Stone's derisive epigram: "Aw, skip it!" The reality is not nearly so nerve wracking. The average driver is far too intelligent and practical to play the fool in this way, and it is only in the over-heated craniums of imaginative enthusiasts that he does so. Many of these fanciful stories, with their voluminous detail, give clear evidence of having their genesis in the buffet-car, not the cab.

There may be virtuosos who coax symphonies out of their engines in this way, but I have never come across them; they must be few and far between. Copperwheat is not one of these geniuses, at any rate, which is probably why I enjoyed watching him so! I am not happy in the company of a genius. Like most good enginemen, he never gets excited about anything that happens on the footplate—he merely flies into a calm. Top link men make "Good enough" their motto as far as possible, and they are quite content to leave things alone when they can.

If an engine is making the even tenor of its way along the level, on three-quarter regulator and 18 per cent. cut-off, the sudden uprising of a mile or two of 1 in 150 does not galvanise the driver into grabbing the reverse-handle, in a frenzy of determination to make the exact punishment fit the crime. Ten to one he does nothing at all. The speed may fall a little, of course—well, let it! So long as running time is not dropped, what matter? From Whitmore to London, I do not think "No. 6229's" cut-off was altered half-a-dozen times, if that. Naturally, over a heavy route, with frequently fluctuating gradients, things are somewhat different, but never, under any circumstances, to the extent the amateur cognoscenti would have us believe. The simplest of all engines that I have watched being handled is "No. 6202," the Turbine. On this, there are no—but that, as a certain departed literary giant was wont to say, is another story!

High speed was still held after Nuneaton, for mile after mile, with the result that Rugby, 14½ miles on, was reached at 6.44½ p.m., 1½ mins. early. After the usual cautious 25 m.p.h. passage of the avoiding line past the station, "No. 6229" again picked up speed rapidly, and on the slight descent from the Kilsby Tunnel, between Welton and Weedon, realising we were travelling faster than usual, I looked at the indicator, to find the needle actually quivering on the 80 m.p.h. line, for the first time since leaving Carlisle.

Along here—for instance, near Blisworth—I again enjoyed watching the perfect co-ordination of attention between Copperwheat and his mate. I had resigned the seat in favour of its rightful owner, and was more or less comfortably wedged into the corner of the tender, between the brake-handle and the door, from whence I had a good view of everything in the cab, and of the track as well. This is actually the best stand-point of all from which to make an all-embracing survey. I admit that it is not the most comfortable position to take up, as it is somewhat draughty, and water is apt to dribble off the top of the tank, finding a resting place on parts of one's anatomy which one would prefer to remain dry. I also discovered that on the "Coronations" it is liable to fall down on to the step, which is on the tender only, where sprightly air-currents flirt with it, pick it up, and fling it merrily back into the cab, accompanied by vagrant coal-dust. A good deal of this mixture settled on my face. But this is all in the game, part of the price I am willing to pay for my locomotive experiences. From this vantage-point, then, I kept an eye on Copperwheat, Tonner, and the signals—in fact, on everything. I would see a signal far off, on an "inside curve"—glance over at Copperwheat—already he would be looking across the cab at Tonner, awaiting his translation of the oracle. The fireman was always ready with his warning hand or affirmative finger to pass the appropriate message to his mate. If I may be permitted the colloquialism, there were never any flies on Tonner! Or on Copperwheat either, for that matter.

From Nuneaton right into London, the "Coronation Scot" was as consistently ahead of time as it had previously been behind it. Wolverton, 246·5 miles, was passed at 7.9 p.m.; the skimpy Linslade Tunnel as usual called for shut firedoor and damper, to prevent an outpouring of flame into the cab, and for closed eyes, to exclude the dust and heat that are always in evidence during its passage, which fortunately does not last long. The coal-pusher was used several times

along here, and it was plain how much labour it saved the fireman.

Tring, near the top of the long 31 miles drop into Euston, was run through at 7.26½ p.m., 4½ mins. early, and Tonner could relax. So could the engine; the fire could burn thinner, and if the pressure fell a little, what did it matter? The fireman said again, in reply to a remark of mine, "No, this isn't really a hard run, if you are feeling O.K. And if the engine feels the same! It is long, not hard." Watching him for five hours, I had already come to that conclusion. There was still a certain liveliness about the running, however; Wembley was passed at 75 m.p.h., and the varicoloured lights of the signals—darkness had fallen—made a pretty kaleidescopic pattern ahead of us as we slowed for Willesden, after which they checked us several times before the "Coronation Scot" came to a stand in Euston at 7.58 p.m., 2 mins. early. It had been a particularly interesting run, confirming several theories of mine about fast-timed trains handled as they should be. Carlisle had been left 2 mins. late; a trifle more time had been lost; the whole then regained, followed by an arrival a little more than punctual, the average speed over the 299 miles from Carlisle having been 64·3 m.p.h. From Glasgow to Carlisle, 102 miles, where the arrival was also early, the average had been 58·6 m.p.h., and over the whole 402 miles, including the single stop, 63 m.p.h. As I covered the two sections on successive days, I will leave the pedants to argue over my right to lump them together.

Several things stand out from this trip. Here was a really fast train, running at a high average speed, 63 m.p.h., yet a maximum of 80 m.p.h. was never exceeded, and only reached twice. As I merely estimated one of these maxima myself, I am not going to swear to it, which leaves but one instance I can be sure of. So much for the breath-taking statements of people who, like the Fat Boy in "Pickwick," love to make one's flesh creep with tales of 100 m.p.h., or more, being frequently touched by the "Coronation Scot." This run was of exactly the kind I like so much; a high average, held up hill, down dale, and on the level, making spectacular peak speeds unnecessary. My trip with the "Royal Scot" was of identically the same nature, the sort of which I should like to see many more on English railways.

I believe the French lines are noted exponents of this kind of thing—a high average, but moderate maximum.

Neither engine was stressed in any way, except on Beattock and Shap, and even then not seriously. They were working well within their power, "No. 6229" simply playing with her job from Shap to Euston. Steaming was free, firing not heavy, and evidently rocking grates are not needed, as fire-irons were never used at all. The look-ahead is good, but I do think window-wipers should be tried out. Not the kind that merely smears dirt over the glass, making confusion worse confounded, but the American pattern, with which hot water plays its part.

So my Scottish experiences ended, and appropriately enough, with another example of the innate consideration on the part of the enginemen to which I have become accustomed. At Euston, as I stepped down on to the platform, Tonner leant out of the cab, and said in a stage whisper: "Your face is a bit dusty!" Do you notice the delicate choice of the word—the obvious wish not to hurt my feelings? Not "dirty"—"dusty!" As a matter of fact, it was neither—it was filthy, to a degree that beggars description; I have explained how this came about, and the rest of my person was like unto it. For a parallel, see the "Mid-day Scot" story. The enginemen, bless their hearts, were far too well-mannered to say so bluntly—they merely hinted at the blatant truth. But just as one touch of nature makes the whole world kin, so does a facial coating of dirt put one on good terms with railwaymen. At London Bridge, I asked a porter which was the right platform for Croydon. "No. 11, mate," came the cheerful reply. "Thanks, chum," I responded, in an equally friendly tone, proceeding happily on my way, thinking what a jolly old world this would be if it were peopled entirely with railwaymen—and if Hitler had been stillborn.

Conclusion

I cannot conclude this series of articles without expressing my thanks to various L.M.S.R. and L.N.E.R. officials, without whose courtesy and help none of them would have been possible. Especially do I wish to acknowledge my indebtedness to Mr. Harvey, L.M.S.R., and Mr. Trask, L.N.E.R., Locomotive Running Superintendents at Glasgow; to the latter in particular for correcting proofs. This also applies to the Operating Departments of the L.M.S.R. in London and Derby.

The Bronx-Whitestone Suspension Bridge

No. II

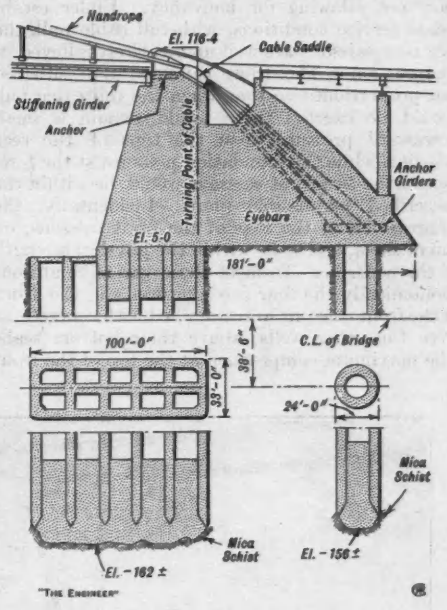
(*Continued from page 464, Nov. 10th*)

THE two main cables have each a finished diameter of approximately 22in. and a net sectional area of wire of 297 square inches. Each cable is fabricated of thirty-seven strands, each strand being composed of 266 wires, cold drawn, and approximately one-fifth of an inch in diameter. The wires are galvanised. The maximum stress in the two cables from dead load, live load, and temperature is 50,200,000 lb. An axial unit stress of 84,500 lb. per square inch was permitted. This is said to be 3 per cent. higher than the corresponding allowance in other large bridges of recent construction; but this was believed justified because of the uniformity and the high average strength and ductility obtainable with cold-drawn wire. More than 4000 tests made in advance gave an average of 233,300 lb. per square inch for strength, an average yield point of 177,500 lb. per square inch, and an average elongation in 10in. of but 6·6 per cent.

In spinning the cables the American Bridge Company, the contractor for the entire superstructure of the crossing, used a similar method and the same kind of equipment that it employed on the suspended spans of the San Francisco-Oakland Bay bridge. The two-grooved spinning wheels carried two loops of wire on each passage, and before the wires went to the spinning wheel from the reels they were reeved through a floating sheave tower. At the cable intersection on a tower the saddle in which a cable was spun had a smooth, circular section instead of being grooved as had been the general practice previously. This form avoided costly machining in preparing the saddle for its service. The wire reels were mounted on non-friction bearings, and they were not motor driven.

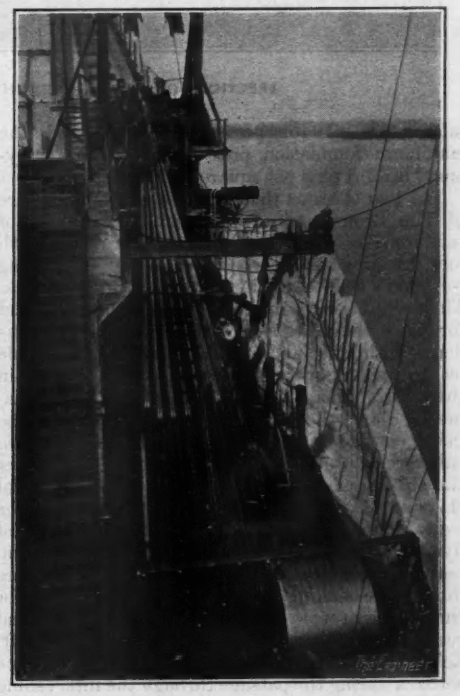
The suspenders are of 2in. pre-stressed wire rope, and each suspender is made up of two separate ropes looped over a grooved band on the cable. The four lower ends are secured to the top of the respective stiffening girder of the suspended span. When tested to destruction over a sheave the suspender rope was required to show a developed strength, in the two parts, of 600,000 lb. The recorded strength shown in three tests varied from 714,400 lb. to 717,800 lb. The maximum stress to which a suspender is subjected in service is 340,000 lb. Landward of the bearings at the anchorage of each cable the strands are splayed and are connected in the conventional manner with the eyebar chains, and the latter, in turn, are secured at their lower ends to girders embedded in the massive concrete of the anchorage structure. The double-web girders were placed horizontally for convenience of erection, and they were set upon a grillage of beams and girders.

The anchorages themselves are a departure in form, great triangular bodies in profile, and severely simple in their modelling so as to harmonise with the other conspicuous features of the bridge. The controlling requirements in developing the design for the two anchorages was that the forward side of each anchorage should be battered at a slope more or less nearly perpendicular to the slope of the cables where they should enter the anchorage, and that the anchorage itself should take approximately the form of the cables where they bend around the rocker arms and enter the concrete. The two side surfaces are broken by four heavy flutes that parallel the offshore battered front of the anchorage, the lines being intended to convey an idea of the forces acting within the anchorage under the pull of the cables. Each anchorage is an immense block of concrete, U-shaped in plan, that has a width of 110ft., a length of 181ft., and a height of 110ft. The rear half of each anchorage is of solid concrete and the front half, on each side, consists of a side wall that is 32ft. thick at the bottom and which is joined at the front face by a thin curtain wall. Above ground the two anchorages are identical, but below the surface the foundations differ because of the controlling conditions at each site. At The Bronx anchorage firm sand and gravel underlie the structure, and its base, which is 15ft.



DETAILS OF QUEENS ANCHORAGE

thick, distributes the pressure on the ground. The required support was obtained by setting the base slab in an open cut that ranged in depth from 16ft. to 21ft. The Queens anchorage is supported by two rectangular and two circular caissons, which were carried down to rock lying at depths ranging from 156ft. to 164ft.—a record depth for such work on the Atlantic seaboard of the country. The two rectangular reinforced concrete caissons, placed at each side beneath the front of the anchorage, were each 100ft. long by 33ft. wide. The two cylindrical caissons that were placed under the rear of the anchorage were each 24ft. in diameter. Each rectangular caisson had ten dredging wells, and each circular caisson, with walls 5ft. thick, had a single central dredging well 14ft. in diameter. All four caissons were started downward from an "artificial island," and sinking was done by the open dredging method. Each of the four caissons was equipped with outside jets at two levels that served to overcome skin friction and there were also 8in. jetting holes cored out in the interior walls



SPINNING OF CABLES

of those structures. When the two rectangular and the two cylindrical caissons had penetrated to the rock then their dredging wells were closed at the bottom with concrete plugs 18ft. in thickness.

The designs of the front and rear caissons at the Queens anchorage were the result of anticipated changing conditions during and after the construction of the bridge. The two rear caissons were called upon to bear a heavier load while the bridge was building than they would after completion. During preliminary conditions the maximum foundation pressure was 44·9 tons per square foot, not allowing for buoyancy. Under established service conditions, with full cable pull, the two rear caissons are well-nigh entirely relieved of compression. The front caissons were situated and proportioned so that when the full cable pull should be exerted there would remain a small downward pressure upon the tops of the rear caissons, while the foundation pressure at the forefoot of the two front caissons would be within the prescribed permissible limit. Incidentally, the compression at the rear of the front caissons, on top of them, had to be within the physical strength of the concrete. To meet these varied conditions economically the four dredging wells in the front of the front caissons were not filled with concrete, as were the other wells, above their bottom seals. The maximum compression at the top of the front caissons is 670 lb. per square inch, and the maximum foundation pressure, neglecting buoyancy, is 32·5 tons per square foot.

The two caissons that underlie the substructure of The Bronx main tower were constructed of reinforced concrete and each was provided with four dredging wells through which the excavating was done that carried them down to bed rock. Their sinking was started from an island of sand formed at the pier site. Each of those caissons was fitted with an elaborate arrangement of outside jets to assist in overcoming skin friction, and within the caisson there were jetting tubes, 8in. in diameter, above the peripheral cutting edge and also in the cutting edges of the cross walls. The jetting tubes were used to introduce pressure jets under the cutting edges primarily to loosen the material there and to start the caissons downward, and the wells were also employed to place charges of dynamite under the cutting edges to break up resistant formations and to serve other purposes during the sinking operations. The caissons for the northern tower functioned as designed and reached bed rock at a maximum depth of 98ft. below mean high-water without any troublesome setback during the passage through the intervening sand, clay, and gravel.

The cutting edges for the two caissons for the Queens pier were all-welded buoyant structures, square in plan, but with rounded corners. Each had an assembled height of 21ft. They were built at Wilmington, Del., and towed from there to the site of The Bronx-Whitestone bridge. Each of these units was double-walled and built with four dredging wells. To aid in getting them down to rock, each of these structures had outside jetting systems, together with interior peripheral and cross-wall jetting tubes, 8in. in diameter. These caissons were sunk by open dredging, and at the start they were loaded in their interwall spaces with sufficient concrete to cause them to sink on to and into the river bed at the pier site, where the water was about 10ft. deep at high tide. As each caisson sank, it was lengthened successively by a series of welded box sections, each 10½ft. high, and this procedure continued until each caisson had a total length of 110ft. As the caissons sank deeper and deeper, the interwall spaces were filled with concrete. Those caissons were put down through a soft mud stratum, 100ft. thick, before coming to hardpan, and then to their seatings on the rock at a maximum elevation of —147·7ft. In sinking the caissons through that unstable mud, great care had to be exercised to keep them upright. The substructures of the two towers and for the two anchorages were built by the Frederick Snare Corporation, of New York City.

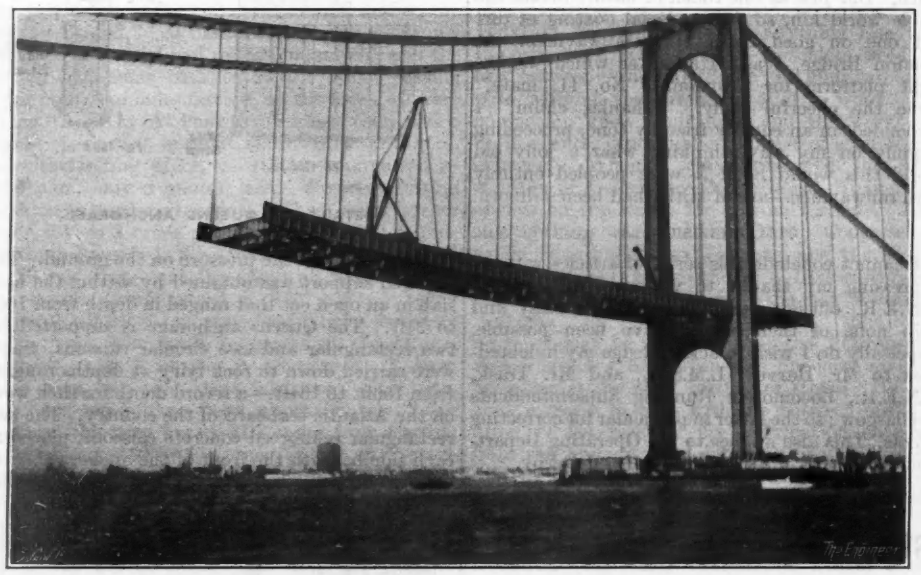
The designers of The Bronx-Whitestone bridge had the following controlling factors in mind in developing the plans for the structure:—The actual dead load of the suspended structure was assumed to be 10,940 lb. per linear foot of bridge in the centre span and 10,780 lb. per foot in the side spans, while the weight at each tower was placed at approximately 3500 tons. The live load, with four lanes of vehicular traffic, was computed at 3000 lb. per foot of bridge in planning the stiffening girders, the cables, the towers, and the anchorages; and for the suspenders the accepted figure was 8000 lb. for the same unit. At a pressure intensity of 30 lb. per square foot of exposed surface, the wind force was estimated at 800 lb. per square foot of bridge acting on the floor, 120 lb. on both cables, and 5500 lb. per foot of height on each tower. A rise or fall of 55 deg. Fah. was the assumed temperature range for determining stresses; and a change of 75 deg. Fah., up or down, was taken into account in allowing for expansion and contraction of the floor.

For structural and economical reasons, the designers decided that the two roadways should be built with a 4½in. concrete slab encasing longitudinal bulb beams and transverse reinforcing rods. However, what is known as the I beam Lok floor was accepted because, in effect, it is much like the design originally planned. The slab rests on cross beams which, in their turn, are set on longitudinal stringers that are framed into the main floor beams. The main floor beams are riveted girders, 6½ft. deep, which are placed alternately at and midway between the suspender ropes. The floor beams are framed into the main longitudinal stiffening girders, one on each side of the floor and in the plane of its respective cable and suspenders. These stiffening girders function as chords of the wind truss and form the outer railings of the two footwalks, each of which has a treadway width of quite 5½ft. The diagonals of the wind truss are located in the plane of the bottom flanges of the roadway stringers, and, together with every second floor beam, form a K system. At each tower the roadway is fitted with expansion joints, and at each anchorage the floor is fixed longitudinally, but open joints permit a measure of deflection. The stiffening girders are discontinued at the towers where their ends are suspended by means of short hinged hangers from brackets that are attached to the towers.

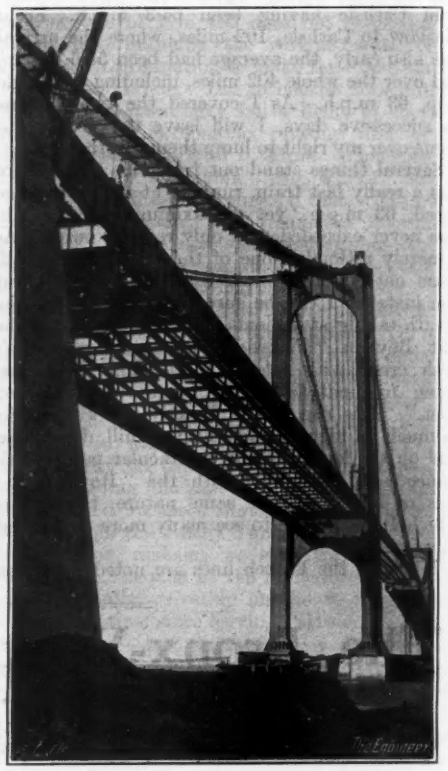
Again, to quote Mr. Ammann: "It is now well established that long-span suspension bridges for modern highway traffic may have a relatively flexible stiffening system, and that the degree of flexibility has a material effect upon the economy of the design. In this respect The Bronx-Whitestone bridge marks another radical departure from past theories and practice. Its stiffening girders have greater flexibility in relation to span length than any other bridge built in recent years, except the George Washington bridge in its present state, with only a single unstiffened highway deck. The latter bridge, however, with a present roadway capacity equivalent to that of The Bronx-Whitestone bridge, has a suspended deadweight per linear foot, 2½ times greater, a centre span 56 per cent. longer, and side spans somewhat shorter, all of which factors contribute to the greater rigidity of the unstiffened cables."

For æsthetic, structural, and economical reasons, the height of the floor structure of The Bronx-Whitestone bridge was kept as low as permissible, the use of trusses was carefully avoided, and studied efforts were made to give the motorist the widest possible range of view. The depth of the stiffening girders was therefore fixed at 11ft., which was found to promise satisfaction in all essential particulars. That depth is but 1/210 of the length of the centre span and 1/70 of a side span. The vertical flexibility is such that the stiffening girders exert but little restraint upon the deformations of the unstiffened cables, except when under heavy local concentrations of load. Under a live load that may cover the centre span and at maximum temperature, the unstiffened cables are expected to deflect 9·85ft. in the centre, while stiffened cables would deflect 9·72ft.—a reduction of only 1·3 per cent. For a live load spread over the central 700ft., the corresponding values are computed to be 10·77ft. and 9·50ft. a reduction of 11·8 per cent. The maximum deflection at the quarter point is put at 9·90ft. without the stiffening girders and at 9·27ft. with them—a reduction of 6·4 per cent. in the latter case. As emphasised by the chief engineer, the function of the stiffening girders is thus, in fact, reduced principally to stiffening the floor system against successive local bending of the floor, and incidentally to act as chords of the wind truss. The maximum changes in grade due to live load and temperature in the floor will occur in the centre span at the towers, where the normal gradient of the roadway is 4 per cent. Low temperature together with live load, might increase the gradient by 3 per cent., though it is expected that the increase under actual conditions will probably never be in excess of 1 per cent. The tilting of the floor transversely at the middle of the centre span, due to live load on but one of the two roadways, is estimated at 6·3 per cent.

The stiffening girders in the centre span were

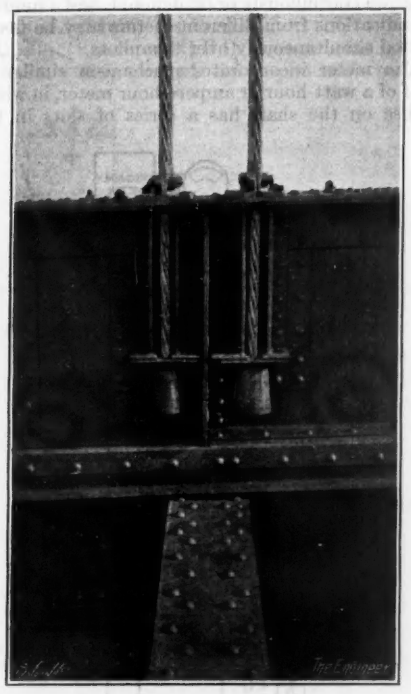


ERECTION OF DECK AT BRONX TOWER BY TRAVELLER CRANE



ERECTION OF FINAL GIRDERS, WHITESTONE SIDE

constructed of silicon steel, being considered the most economical material for those members. The unit stress for a combination of wind, temperature, and one-half live load is put at 30,800 lb. per square inch in tension and 25,300 lb. per square inch in compression. The axial stress due to wind is predominant, and so as to make the section strong enough to resist buckling, the girder web was made $\frac{3}{8}$in. thick and stiffened by longitudinal angles. In the side spans a maximum combination of live load, temperature, and one-half wind load may cause unit stresses of 25,300 lb. in tension and 22,100 lb. per square inch in compression. Therefore carbon steel was considered adequate in that part of the structure. Inasmuch as the axial stress from wind is small in the side spans, no strengthening of the $\frac{1}{4}$in. web was required in their stiffening girders to prevent buckling. The weight of both stiffening girders is only 1540 lb. per foot of bridge in the centre span and 1250 lb. per foot in the side spans. The wind truss is hinged at the towers and at the anchorages. Having a width of 74ft. between the stiffening girders, the truss is fairly flexible, and with an 800 lb. wind force



CONNECTION OF SUSPENDER ROPES TO STIFFENING GIRDER

acting directly on the floor, there is a resultant average of 300 lb. transmitted to the cables. The lateral deflection of cables and floor at the centre of the main span under full wind force is 8·5ft., or 1/270 of the centre span. The wind truss diagonals are of carbon steel and have an average weight of but 207 lb. per foot of bridge.

On The Bronx side of the river the approach viaduct has a length of 2360ft., and on the Queens side of the waterway the approach viaduct has a length of 1620ft. The superstructures of both viaducts are made up of continuous plate girder spans, which are carried by a succession of reinforced concrete piers. The sidewalks and the roadways on these approach structures are identical with the corresponding features of the suspension bridge. From an engineering point of view, the approaches are not unusual in any respect.

The Bronx-Whitestone bridge and its approaches have required the use of 22,300 tons of steel, exclusive of reinforcing metal in the concrete. Of that total, 14,500 tons is structural carbon steel, 3030 tons is silicon steel, 4370 tons is steel wire, and 400 tons consists of steel castings. There are about 200,000 cubic yards of concrete in the foundations, the piers, and the anchorages. According to a statement issued by Mr. Robert Moses, Chairman of the Triborough Bridge Authority, the total outlay up to May 1st of the current year—that is 17,785,000 dollars—embraced the following three items :—Construction, including overhead engineering and contingency reserve, 15,219,000 dollars; real estate, 1,070,000 dollars; interest to April 29th, 1939, 1,496,000 dollars; total, 17,785,000 dollars. This debt is to be amortised in the course of thirty-one years by payments starting on April 1st, 1942.

Structurally, the undertaking was covered under five major contracts :—The anchorage and tower foundations were built by the Frederick Snare Corporation; the anchorage superstructures and the approach piers were erected by Corbetta Construction Company, Inc.; and the towers and the entire superstructure were built by the American Bridge Company.

The engineering staff assisting Mr. Ammann was composed of Messrs. E. W. Stearns, assistant chief engineer; Allston Dana, engineer of design; and E. W. Bowden, assistant to the chief engineer. Aymar Embury II was the architect; the consultants were Messrs. Leon S. Moisseiff, Professor Charles P. Berkey, the firm of Moran, Proctor, and Freeman; the consulting engineering firm of Madigan-Hyland was in charge of the planning of the parkway connections and the construction work of the entire project; Emil H. Praeger is chief engineer of that organisation, and Colonel Harold W. Hudson was engineer of construction. Work was started on the undertaking on June 14th, 1937, and the bridge was ready for opening to traffic twenty-three months later. Engravings illustrating its construction appear on page 496.

Remote Supervisory Control

No. II

(*Continued from page* 467, *Nov.* 10*th*)

THE part played by the apparatus described in the previous article should be apparent from the simplified diagrams Figs. 13 to 16. Before any item of switchgear can be operated, the sub-station in which it is situated must be selected from the others in the undertaking, and the circuit action is similar to that to be described in connection with the selection of plant. Although the system provides for selection over two pilot wires, for the sake of simplicity an additional pilot wire is shown. Suppose a circuit breaker is to be controlled and supervised. In the mimic diagram on the control panel this breaker is represented by a key and three lamps, and the key is positioned on the panel so that the control apparatus appears in the line representing the appropriate power line.

When the conditions are normal, the circuits are shown in the diagram, Fig. 13, by the heavy lines, where it will be seen that the "off" lamp glows and that the sub-station relay ZS on the left of the diagram is held operated over the circuit-wipers R1 and S1 of the receiving and sending selectors respectively. The handle of the control key breaks the line representing the power transmission line.

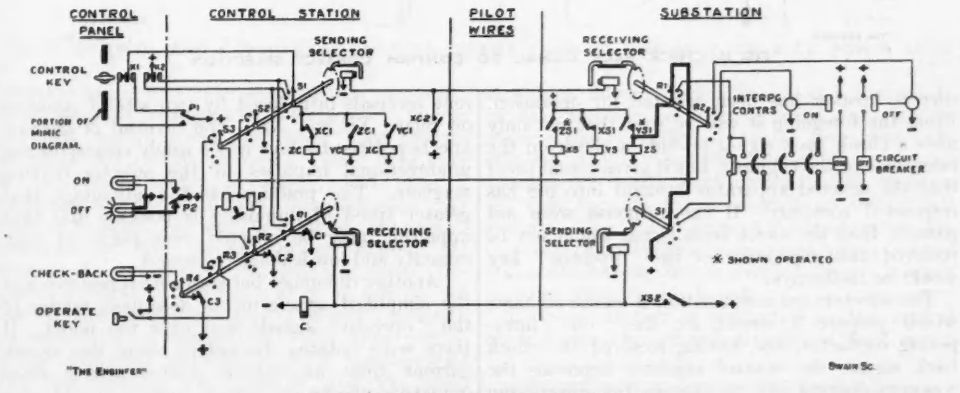


FIG. 13—NORMAL CIRCUIT CONDITIONS

When the control engineer desires to close the circuit breaker, the control handle is turned in alignment with the mimic diagram as shown in Fig. 14. The object is now to cause the control station sending selector to step to the contact marked by the operation of this control key, and at the same time to step the sub-station receiving selector in unison. At the moment of turning, the key wiper S1 at the control station is resting on the first contact and the circuits are those shown by heavy lines. With the key contacts K1 and K2 (shown adjacent to the control key) operated, after the key is turned, the positive pole is extended *via* contact P1, contact K1 wiper S1, contact XC1 to the operate relay ZC.

This relay is one of three which form an impulsing chain as follows: Contact ZC1 operates relay YC; contact YC1, relay XC; and contact XC1 releases relay ZC, whilst contact ZC1 releases relay YC, which in turn releases XC. With relay XC released, a circuit is again established at XC1 for relay ZC and the cycle recommences. Hence, as long as a positive battery is extended to relay ZC the cycle continues, and each relay is operated and released in turn. Contact XC2 is therefore made and broken in a definite cycle, and feeds impulses to a pilot wire.

On receipt of the first impulse, the control station sending and sub-station receiving selectors take one step. With wipers S1 standing on the second contact, a circuit is again completed for the impulsing chain, the cycle is repeated, the two selectors stepping to the third contact. On this contact the sending selector no longer establishes a circuit for the relay chain and the impulsing ceases. Hence, the circuit conditions at the control station when this control key is turned to the "on" position, cause the receiving selector at the sub-station to step to the third contact to which is connected (on arc 2) the interposing contactor for closing the circuit breaker). Correct selection has therefore been carried out, but before actual operation can be effected a signal in confirmation is given on the check back lamp.

When the receiving selector stepped from the first contact, the circuit holding relay ZS was

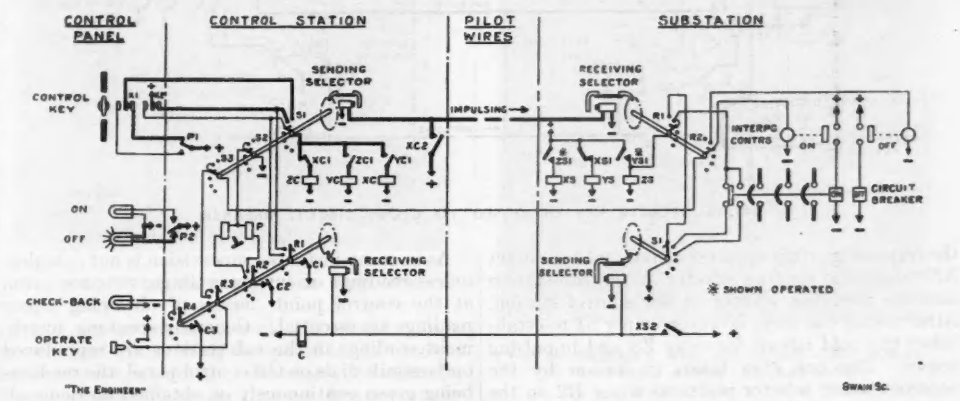


FIG. 14—CONDITIONS AFTER CIRCUIT BREAKER CONTROL KEY IS TURNED

broken. Relays ZS, YS, and XS form the sub-station impulsing group and with the removal of the hold on relay ZS, the group operates in a manner similar to that of the group at the control station. Contact XS2 in the lower part of the diagram, Fig. 15, steps the sub-station sending and control station receiving selectors. With the sending selector on the second bank contact, a holding circuit is again established for relay ZS and impulsing ceases. Relay C at the control station (shown in the lower part of the diagram) is a slow-to-release relay and is held during impulsing and is released when impulsing is complete. Contact C2 holds relay P (which is a two position relay) in a position which maintains a circuit for the open lamp *via* contact P2, while contact C3 lights the check back lamp associated with the breaker, to provide confirmation that the

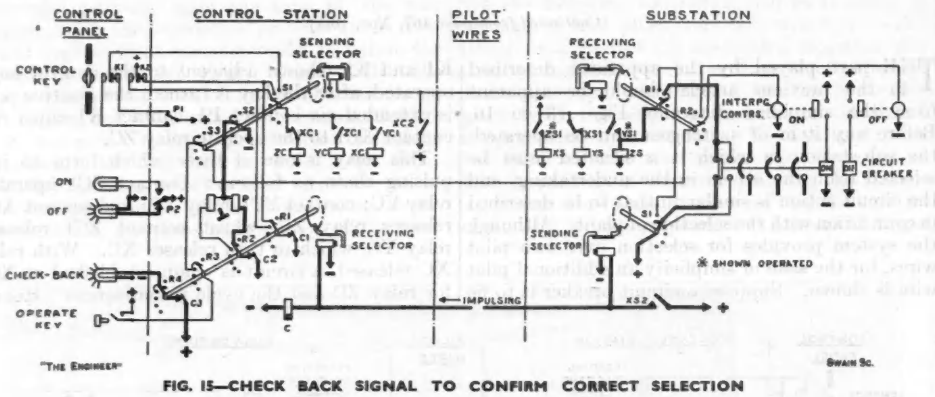


FIG. 15—CHECK BACK SIGNAL TO CONFIRM CORRECT SELECTION

correct breaker has been selected for operation. From the foregoing it will be seen that not only does a check back signal provide a check on the intentions of the engineer, but it gives visual proof that the selected apparatus brought into use has responded correctly. If the response were not correct, then the check back signal would not be received and depression of the "operate" key would be ineffective.

The selectors are now positioned on the contacts which prepare a circuit for the "on" interposing contactor, and having received the check back signal, the control engineer depresses the common operate key to operate the interposing contactor over a circuit shown in Fig. 16, thus closing the circuit breaker. When the breaker closes, the auxiliary contacts change over and break the circuit which held relay ZS. Hence,

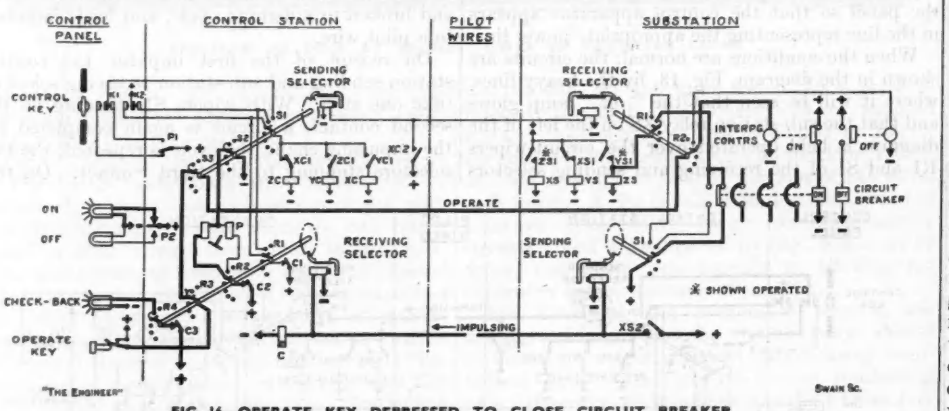


FIG. 16—OPERATE KEY DEPRESSED TO CLOSE CIRCUIT BREAKER

the impulsing group operates again, and at contact XS2 steps the sending selector at the sub-station and the receiving selector at the control station. After taking one step, however, wiper S1 re-establishes the hold circuit for relay ZS and impulsing ceases. The one step taken in unison by the control station selector positions wiper R2 on the contact connected to the second coil of relay P which operates at contact P2, extinguishes the off lamp and lights the "on" lamp when operation and indication are complete.

When relay C released at the end of the final impulse, a circuit was established *via* contact C1 and wipers R1, S1 for the impulsing group which operates and drives the selectors back to their normal position in readiness for the next operation, the check back lamp being extinguished on the first step of the receiving selector since wiper R4 breaks its circuit. The red lamp, however, continues to glow, for although the circuit for relay P, is broken by wiper R2, spring action holds the relay in the position in which contacts P2 maintain a circuit for the lamp. The "on" indication thus continues until position is changed. While only one circuit breaker is shown in the diagram, it will be understood that a number can be dealt with similarly, the control key, lamps, auxiliary contacts, etc., being connected to other contacts on the selector banks in a like manner to that shown. The number of breakers which can be dealt with is therefore limited only by the number of contacts on the selector. The number is commonly 50, although this can be increased if needed. Associated keys are connected to corresponding contacts on the control station sending selector, and operation of any key gives rise to a cycle similar to that described.

With regard to the impulsing over pilots, it is to be noted that in actual practice this is not effected by the simple application of positive potential by contacts XC2 and XS2 but by current reversals introduced by two sets of contacts on relays XC and XS. The reversal of current affects polarised relays which apply corresponding unidirectional impulses to the selector driving magnets. This practice has the advantage that greater speed of impulsing is possible and that impulsing may be effected over pilots of high capacity and low leakage resistance.

Another difference between actual practice and the simplified arrangements described, relates to the "operate" signals sent over the pilots. If there were nothing distinctive about this signal, current from an outside source arising from inductive effects or chance contact would give rise to a false operation. But the operate signal is a current of 90 cycles per second, and the possibility of its being simulated in sufficient strength and at the appropriate time is negligible.

As in many instances supervision is not complete unless readings of current voltage, etc., are given at the control point, means of obtaining meter readings are essential. Generally speaking, instrument readings in the sub-stations are reproduced on facsimile dials on the control panel, the readings being given continuously or obtained on demand. Usually the latter practice suffices, and it has the merit that it simplifies the metering equipment. A process of selection similar to that described enables any meter to be selected for reading, depression of the "operate" key then causing the indication to be reproduced on the corresponding meter on the control panel. For current and voltage readings, the obvious practice is to employ auxiliary current and voltage transformers or shunts and potentiometers, selected as required for direct connection over the pilots to the appropriate control station meters. This method is adopted when four pilots are available, but when operation is effected over a less number of pilots and in the case of other kinds of readings direct metering is not employed. Indications are then transmitted over the pilots in the form of signals originated at the sub-station and interpreted at the control centre. While the means of originating signals for different types of meter readings vary, two schemes of remote metering cover most requirements.

A method of obtaining "on demand" readings employs modified meters at the sub-station. To the pointer is fixed a small flat spring which moves over an arc of contacts, but does not touch them. After the meter has been selected, depression of the operate key causes two sectors actuated by electromagnets to press the spring on to a contact. The supervisory control apparatus at the sub-station responds to the circuit thus established and sends impulses over the pilots, the number of impulses depending on the pointer's position. At the control station a both-way uniselector operates in sympathy, and being fitted with a pointer and an appropriately calibrated scale reproduces the reading at the sub-station meter.

Another method of metering is one which uses a watt-hour mechanism incorporating a photo-cell and amplifier interrupter. By means of this, indications faithfully following all fluctuations may be given continuously or on demand, and a number of indications from different meters may be transmitted simultaneously over two pilots.

The meter incorporates mechanism similar to that of a watt-hour or ampere-hour meter, in which a disc on the shaft has a series of slots in the

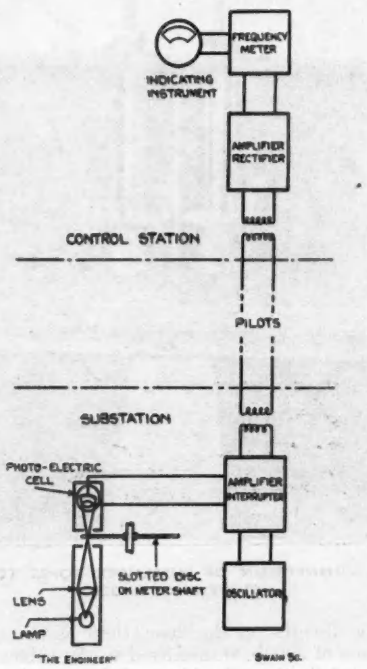


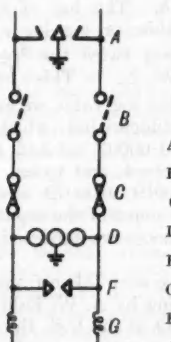
FIG. 17—PRINCIPLE OF REMOTE METERING

periphery. Rotation of the shaft causes the slots to pass between a source of light and a light cell. The path of the light is thus interrupted at a rate which is dependent upon the speed of rotation and thus proportional to the quantity being measured. This action, which is illustrated diagrammatically in Fig. 17, gives rise to variations in potential which are impressed on the grid of a valve which serves as an amplifier of the output of an oscillator, but when the light cell is conductive the potential impressed on the grid of the valve biasses it to such an extent that current cannot pass to the pilots. The output of the oscillator is thus interrupted at a speed dependent on the speed of rotation of the disc. The interrupted current passes over the pilots to the control station, where rectification by an amplifier rectifier produces a current of frequency equal to that of the original variations. A receiving relay responds and alternatively charges and discharges two condensers, whilst a meter measures the changing current and thus provides an indication proportional to the quantity to be measured. By the use of oscillators generating different frequencies, together with suitable filters, a number of indications can be sent simultaneously. Moreover, they may be sent over pilots actually in use for telephony or for the remote control of plants. This same principle may be employed for the remote indication of the reading of any meter or similar device in which rotary speed varies with the quantity to be measured.

Preferably, pilot wires should be allocated exclusively for the purpose of remote supervisory control, and since the facilities offered include telephone communication pilot wires already in

service for this purpose may be taken over. As already indicated, the G.E.C. system may be operated over pilot wires in use for other purposes, provided the condition of the wires is suitable. Generally speaking, pilots of low capacity and high insulation resistance are advisable. When electric power cables are laid underground, pilot cables are generally laid alongside and afford feeder protection and telephone communication. Wires in these pilot cables may be used for supervisory control, telephone pairs in particular, screened from inductive interference, providing an excellent channel. In overhead power distribution systems pilot cables are generally carried on the same towers as the H.T. lines. Sometimes they are suspended from a catenary wire or in other cases take the form of a catenary cable, a combined earth wire and pilot cable or open wires. As the pilots are exposed to the electro-magnetic and electro-static fields about the power lines, measures are taken to protect the supervisory control apparatus and operating staff. Provision is also made, where necessary, to guard against the effects of actual contact with power lines and when the pilots consist of open wires, the effects of lightning discharges.

In Fig. 18 is shown G.E.C. arrangements for the complete protection of the supervisory control



A—Horn gap arrestor.
B—Isolating links.
C—Fuses..
D—Roller gaps.
F—Wire to wire gap.
G—Chokes.
H—Drainage coils.
J—Isolating transformer.
K—Low-tension protector.
T—Telephone or supervisory control apparatus.

FIG. 18—PILOT WIRE PROTECTION

system, when the pilots are formed by open wires. Horn gaps and chokes afford protection against lightning surges, and isolating switches and links serve to disconnect the terminal equipment whilst adjustments are made. Roller gaps provide protection against the effects of actual contact between pilots and power lines, and are set to break down at a safe value for the insulation of the circuit, so that fuses blow and isolate the pilot line from the terminal apparatus. As the two gaps will not generally break down at exactly the same instant, the effect is to impress momentarily a high voltage between the two wires. The sudden setting up and subsequent discharge of this wire to wire voltage would, in the absence of protection, produce intense acoustic shock in any telephone receiver connected at the time and might damage the supervisory equipment. A wire to wire gap is therefore set to break down at as low a voltage as is feasible to mitigate these effects. Voltage arising from longitudinal electro-magnetic induction from the power line is continuously discharged by drainage coils and finally the isolating transformer protects the terminal equipment from such voltages as are not otherwise discharged by the spark gaps and drainage coils. It is unnecessary to employ all these protective devices if a catenary cable is employed. Where, as in the example cited, isolating transformers are included an A.C. signalling system is employed in order to effect the selection of the plant described. A.C. signalling also enables operation to be effected over phantom circuits, and has in fact much to commend it in some instances of two-wire operation. A specialised application employing currents with a frequency range within the voice range and is necessary when pilots are rented from a telephone administration.

When sub-stations are separated by considerable distances, the cost of installing pilot wires may make remote supervisory control uneconomical. It is sometimes customary in these cases to rent lines from the telephone administration, but this has the inherent drawback that the continuity and maintenance of the lines are not under the control of the electric supply authority, and since such rented lines are usually incorporated in multi-core cables along with other ordinary telephone circuits, there is always the possibility of interruptions being caused by the telephone administration staff.

A more reliable alternative advocated by the G.E.C. is to employ carrier currents superimposed on the power lines. Systems of remote control operating on this principle have been put into operation by the company on power lines operating at voltages as high as 132 kV. Irrespective of

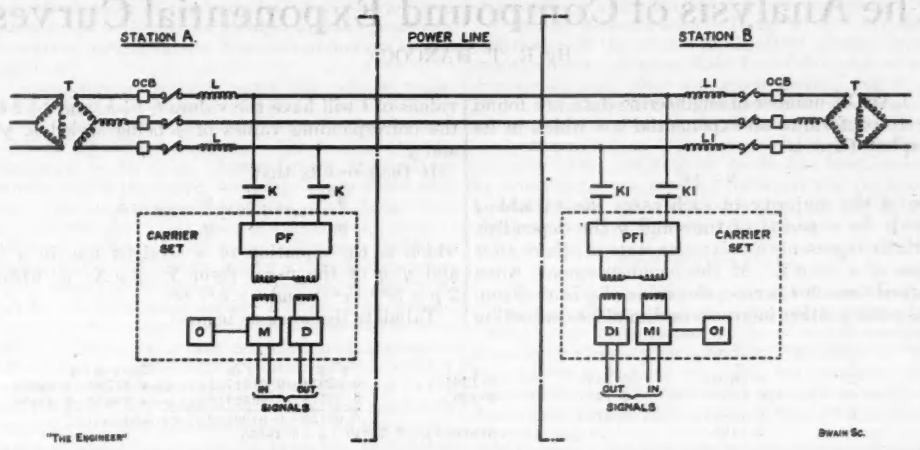


FIG. 19—CONTROL AND COMMUNICATION OVER CARRIER CURRENT CHANNELS ON E.H.T. POWER LINES

whether pilots or carrier channels are employed, a full range of facilities can be employed. Carrier currents superimposed on power lines provide an inherently reliable channel. Power lines have a very high factor of safety, and even if breakage of the line occurs communication may still be possible. In Fig. 19 is shown the general principle of the carrier current system. At station A, an oscillator O generates carrier frequency usually in the range of 50 to 200 kc. per second, and this is modulated at M with the signals or speech to be transmitted. The filter portion of the protective and filter unit PF, together with the line coupling condensers K, and the tuned choke L forms a band pass filter which allows the carrier frequency and its associated side bands to

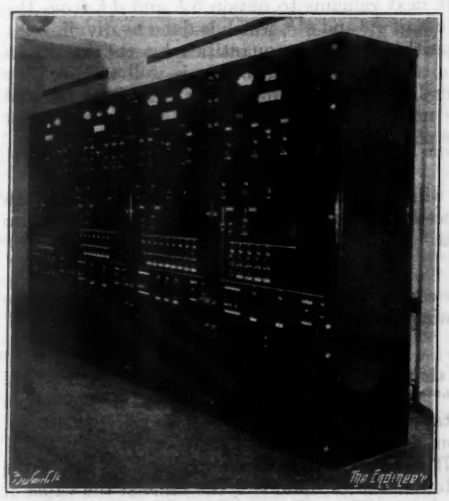


FIG. 20—CONTROL PANELS AT 3RD SEPT. STREET

pass to the power line, while the choke coils L prevent them from being dissipated in the terminal power station apparatus. Having a low capacity the condensers K prevent power frequency currents flowing into the carrier apparatus and are insulated for the full line voltage, while the unit PF incorporates additional protection in the unlikely event of the failure or flash over of a condenser.

At station B the line coupling apparatus passes the carrier frequencies to the demodulator D1, where they are rectified to reproduce the original signals. Signalling in the reverse direction is effected in a similar manner *via* oscillator O1, modulator M1, and demodulator D, and since a different frequency is used for each direction, signalling is effected in both directions simultaneously. Bridging arrangements enable the carrier channel to be maintained across switching points at times when the power line is open circuited, whilst portable choke coils may be employed to earth the line when maintenance work is being undertaken.

Among the applications of the G.E.C. remote supervisory control system working on the principles described in connection with the diagrams, 13–16, is that installed in Athens. The sub-stations at Zappeon and at Ambelokipi on the Kephissia road are situated mainly in residential districts, and cater primarily for domestic load in addition to D.C. power supply for traction. A considerable industrial load is met by two other sub-stations at Attiki and Ellis Street. The Attiki station is near the terminus of the Athens-Kephissia railway, which has been converted to electric traction to link up with the Athens-Piraeus electric railway. In the four main sub-stations, G.E.C. pumpless air-cooled steel clad mercury arc rectifiers are installed. The rectifiers are feed through transformers from the 22 kV system. The four principal sub-stations are remotely controlled and supervised from a control point situated in 3rd September Street, a short distance from Omonia Square.

Each sub-station is connected to the central control room by individual pairs of pilot wires.

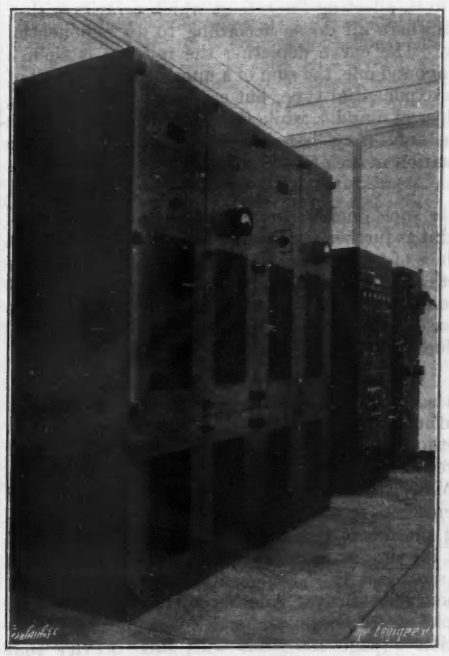


FIG. 21—MERCURY ARC RECTIFIERS AND LOCAL CONTROL PANEL AT ZAPPEON

The facilities provided over the allotted pair in respect to each sub-station are (*a*) operation of all circuit breakers; (*b*) indication of their position; (*c*) indication of volts on the 6·6 kV and 600-volt bus bars; (*d*) indication of current through all A.C. breakers; (*e*) telephony; (*f*) fire alarm, actuated by thermostat in sub-stations; and (*g*) watchman's service in which the turning of a key in the sub-station results in a signal at the control room to indicate the watchman's visit.

In the load dispatcher's room is the control cubicle, Fig. 20, which consists of four panels, each allotted to a sub-station and carrying keys and lamps arranged in a mimic diagram of the undertaking to represent the circuits or equipment they control, or in respect of which they give indications,

the control apparatus being mounted inside the cubicles.

An unusual feature of the system is the provision at each sub-station of a control cubicle complete with control panel and local indicating meters, and Fig. 21 shows the local control panel adjacent to the rectifiers at Zappeon. From this panel all the switchgear in the station may be controlled locally, and the current and voltage of the various circuits can be indicated on meters with individual push button control, so that no metering on the switchgear itself is necessary. Any change in switchgear position arising from local control or as the result of a fault in the power line is at once signalled and indicated at the control room.

In the aggregate, the remote supervisory control system is applied to 62 circuit breakers and is arranged for application to an ultimate total of 96.

(To be continued)

The Analysis of Compound Exponential Curves

By R. T. HANCOCK

A LARGE number of engineering data are found to conform to an exponential law which in its simplest form is

$$y = a\,e^{b\,t},$$

and in the majority of such cases the variable t stands for a period of time and y the dependent variable represents a particular state of affairs after lapse of a time t. At the commencement, when elapsed time or t is zero, the value of y is a. From this point y either increases or diminishes according to whether the sign prefixed to b is plus or minus. The rate at which y is changing is proportional to its magnitude at that moment. A plot of t against log y gives a straight line, the equation of which is

$$\text{Log } y = \log a \pm (b \log e)\,t,$$

from which a and b can be determined in the usual manner. Log e is a constant, 0·4342945, and is brought into the equation to facilitate subsequent operations involving the calculus; otherwise the term in brackets might equally well have been represented by (b'). A plot on semi-logarithmic paper of y against t gives a straight line, from which the constants can also be determined.

Cases occur in which more than one influence is at work affecting the rate at which y varies with t, but where all do so according to an exponential law. The curve depicting the relation is then a compound one, the sum of a number of curves all of the exponential type, but each with its individual values of a and b, while the signs prefixed to these constants may be either plus or minus. The equation in such a case might read

$$y = a\,e^{b\,t} + c\,e^{d\,t}.$$

Only such double curves will be considered here, and it is further essential to their solution that the values of t should be equidistant or form an arithmetical progression. The solution of certain classes of data may result in a value for d of zero, or so close to this that we suspect this to be its real value, and then the equation takes the form

$$y = a\,e^{b\,t} + c.$$

If the value of c also turned out to be zero we should find ourselves back at the simple form. The method to be explained is a general one for all three cases.

Many distinguished mathematicians have applied themselves to the discovery of a method of analysing these compound curves. A practical method for the simpler cases was evolved by Walsh, which is discussed in "Exponentials Made Easy," by Gheury de Bray. Another method is given by Lipka in "Graphical and Mechanical Computation" (page 156), but with such brevity that essential steps are omitted. The method now to be given differs in some respects from both these in the direction of greater simplicity.

As there are four constants to be worked out, four sets of data are required and the values of t must form an arithmetical progression. When data are secured at equal intervals of time, as is usually the case, this last condition is secured. If there is any choice in the matter the points should be chosen where the curvature is most pronounced, as the effect on the constants of small errors on a flat curve is large. A large number of significant figures must be carried at each stage and nothing less than the use of seven-figure logarithms or of a calculating machine is really satisfactory. Even then there is the probability that the resulting equation will not fit exactly at the data points.

Let there be four corresponding pairs of values in t and y and the difference between successive values of t be h, a constant. Three successive values of t will have the values t, $t+h$, and $t+2\,h$, the corresponding values of y being styled y, y', and y''.

It then results that

$$\frac{y''}{y} = (e^{b\,h} + e^{d\,h})\frac{y'}{y} - e^{(b+d)h},$$

which is the equation of a straight line in y''/y and y'/y of the usual form $Y = 2\,p\,X - q$, where $2\,p = (e^{b\,h} + e^{d\,h})$ and $q = e^{(b+d)h}$.

Tabulate the work as below :—

t	y	y'	y''	y''/y	y'/y	$(2p)\,y'/y - q$
2	0·1670	0·1530	0·1385	0·82934 = 0·91617	(2 p)	$-q = 4·31789 - 3·48855$
4	0·1530	0·1385	0·1190	0·77778 = 0·90523	(2 p)	$-q = 4·26633 - 3·48855$
6	0·1385	0·1190		0·05156 = 0·01094	(2 p)	(by subtraction)
8	0·1190			Whence $p = 2·35649$: $q = 3·48855$		

What follows next is the solution of a quadratic, of which the two roots are $e^{b\,h}$ and $e^{d\,h}$, where $e^{b\,h} = p + \sqrt{(p^2 - q)}$ and $e^{d\,h} = p - \sqrt{(p^2 - q)}$. We can obtain these roots as follows :—

$$\begin{aligned} & p \pm \sqrt{(p^2 \quad - q)} \\ & 2·35649 \pm \sqrt{(2·35649^2 - 3·48855)} \\ & 2·35649 \pm \sqrt{(5·55304 \; - 3·48855)} \\ & 2·35649 \pm \sqrt{(2·06449)} \\ & 2·35649 \pm 1·43683 \end{aligned}$$

whence $e^{b\,h} = 3·79332$ $\quad e^{d\,h} = 0·91966$

A check on the preceding arithmetical work can be obtained by observing that the sum of these two values $= 2\,p$, while their product $= q$. It will sometimes happen that q, as found above, is greater than p^2, which means that the quadratic has no real roots and that the data cannot be fitted to an exponential form.

It next remains to obtain $b\,h$ and $d\,h$ from the values of $e^{b\,h}$ and $e^{d\,h}$, which is done by dividing the logarithms of these quantities by the logarithm of e, which is 0·4342945. It is well to check by long division as close figuring is necessary here, and the numerical values should be taken to at least five places of decimals. The present results are :—

$$b\,h = 1·33325 \qquad d\,h = -0·08375$$

It will be observed that h, the interval between successive values of t, is 2 in the present data, so that

$$b = 0·66662 \qquad d = -0·04187$$

We can now set down the equation at which we are aiming in the form

$$y = a\,e^{0·66662\,t} + c\,e^{-0·4187\,t},$$

so that if we work out the values of $e^{0·66662\,t}$ and $e^{-0·04187\,t}$ for a pair of values of t in the given data we shall obtain two equations in a and c, from which we can obtain their values.

It so happens in the present case that one of the values of t in the data is 2, the same as the value of the interval h, so that for $t = 2$ we have $e^{b\,t} = e^{b\,h}$ and $e^{d\,t} = e^{d\,h}$. The values of $e^{b\,t} = 3·79332$ and $e^{d\,t} = 0·91966$ for $t = 2$ can therefore be set down immediately. We look up the logs of these last two figures and proceed to tabulate, observing that to obtain the log values for the remaining values of t we shall simply have to add these logs successively.

t	y	$e^{b\,h}$		$e^{b\,t}$
2	0·1670	3·79332 = 0·5790195	=	3·7933
4	0·1530	= 1·1580390	=	14·3893
6	0·1385	= 1·7370585	=	54·5831
8	0·1190	= 2·3160780	=	207·0513
t	y	$e^{d\,h}$		$e^{d\,t}$
2	0·1670	0·91966 = $\bar{1}$·9636273	=	0·91966
4	0·1530	= $\bar{1}$·9272546	=	0·84577
6	0·1385	= $\bar{1}$·8908819	=	0·77783
8	0·1190	= $\bar{1}$·8545092	=	0·71533

Taking pairs from the first and last lines of these values, we set down :—

$$\begin{aligned} y \qquad & a\,e^{b\,t} + c\,e^{d\,t} \\ 0·1670 = \; & 3·7933a + 0·91966c \\ 0·1190 = 207·0513 & a + 0·71533c. \end{aligned}$$

Divide the top line throughout by 3·7933 and the bottom line by 207·0513, which is comparatively easy, as we have already most of the logs we need, then

$$\begin{aligned} 0·04402 &= a + 0·24244\,c \\ 0·00057 &= a + 0·00345\,c \\ \hline 0·04345 &= \quad 0·23899\,c \end{aligned}$$

whence $c = 0·18180$

and $a = -0·00005$.

The complete equation can now be stated as

$$\begin{aligned} y = & \quad -a\,e^{b\,t} \quad + \quad c\,e^{-d\,t} \\ y = & -0·00005\,e^{0·66662\,t} + 0·18180\,e^{-0·04187\,t} \end{aligned}$$

It is now as well to compute the values of y which this equation will yield for the data values of t and compare them with the given values. We shall find

$-a\,e^{b\,t} + c\,e^{-d\,t} =$	y	
−0·00019 + 0·16720 =	0·16701	*cf.* 0·1670
−0·00072 + 0·15377 =	0·15305	0·1530
−0·00273 + 0·14142 =	0·13869	0·1385
−0·01035 + 0·13005 =	0·11970	0·1190

which is about as good an agreement as can be expected from computations of this nature.

The calculation of these last figures is quite easy if the work is suitably tabled. For $a\,e^{b\,t}$, for instance, we have to multiply a by successive values of $e^{b\,t}$ differing by h. The log of e is 0·4342945 and the log of this, or log log e, is $\bar{1}$·6377848. To this last add twice the log of 0·66662 (twice, because $h = 2$). This gives $\bar{1}$·7626931, and as this is a log log value we must look up the value of its antilogarithm, which is 0·5790193. To the log of 0·00005 we add this last, once for $t = 2$, twice for $t = 4$, and so on, the results being the logs of 0·00019, 0·00072, and so on. In the case of $c\,e^{-d\,t}$, on account of the negative sign of d, we have to make successive subtractions instead of additions.

The data in the present case were taken from an investigation into batch-milling by A. W. Fahrenwald, as recorded in R.I. 2989 of the U.S. Bureau of Mines, Table 2, and represent the rate of production of minus 48 mesh product.

Institution of Electrical Engineers*

IN his Address in 1927, Sir Archibald Page dealt very fully with the history of electricity supply in Great Britain prior to the passing of the Act which established the Central Electricity Board. At that time the construction of the Grid had just begun. In the interim, several papers have been presented to The Institution dealing with the various aspects of Grid design and construction novel to this country. The novelty of construction has now passed away, the Act is familiar to members of the supply side of the industry, and, in addressing The Institution generally, matters must be mentioned which to some may appear hackneyed. I feel, however, it will be useful to The Institution at this critical juncture to have an account of the Grid as an established entity, and to summarise some of the experience gained and progress made from an engineering and national standpoint since the passing of the 1926 Act.

GRID CONSTRUCTION

While that original scheme was generally adhered to when detailed plans came into practice, it is undesirable, for obvious reasons, to publish any detailed comparative maps at the present time. The only part of the country now not covered by a scheme in full operation is North Scotland, for which no scheme is at present contemplated.

This country has comparatively little need to transmit power over long distances, as sources of energy are adjacent to each other and to load centres. The general underlying functions of the interconnecting system provided by the Grid are :—

(*a*) To reduce the proportion of reserve plant required in individual stations, and

(*b*) To secure the highest practicable load factor for the most efficient plant on the system.

Interconnection of a similar kind had already been put into operation on a large scale abroad and on a relatively modest scale in this country, but the Grid constitutes the first application of these principles to the electricity supply system of an entire country.

The financial results up to the outbreak of war are even better than those envisaged in the programme of development. The Grid construction and standardisation of frequency, planned in the comparative prosperity of 1924–1929 and carried out largely in the period of acute depression which followed, resulted in a substantial increase above the normal capital expenditure of the industry at a time when such expenditure was most needed. The policy has had

* Abstract of Mr. Johnstone Wright's I.E.E. Presidential address, arranged to have been delivered prior to the outbreak of war, on Thursday, October 26th.

the less tangible, but possibly equally valuable, effect of affording our manufacturers extensive and intensive experience in design and construction of large high-voltage power plant, thus putting them in a position of equality with their competitors abroad.

Standardisation of Frequency

In 1924–1925 seventeen different frequencies were employed in the alternating-current systems of Great Britain, and no less than 80 undertakings were distributing alternating current at frequencies other than 50 cycles per sec. The existence of large systems operating on a variety of frequencies was a grave handicap to commercial development and seriously limited the benefits to be obtained from a comprehensive scheme of interconnection.

The experts advising the Weir Committee considered that the standardisation desirable for grid purposes, if undertaken in 1924, would cost £10½ millions. When the Electricity Commissioners prepared the detailed schemes, the estimated figure had risen to about £14½ millions, and by the time the work was actually put in hand, on dates spread over 1928 to 1930, the estimated gross cost was some £18½ millions. The actual expenditure up to the end of 1938, when the work was virtually complete, was £17·3 millions, some part of which is recoverable as antedated expenditure subsequently needed to meet normal development. The magnitude of this increase in cost with efflux of time clearly indicates that the cost of standardisation would have become prohibitive if further delayed. Indeed, but for the retarded expansion of industry during the trade depression from 1930 to 1934, the amount of apparatus to be dealt with would have been greater; had the decision to standardise been delayed until the present time, the cost would have been well over £30 millions. The industry has been relieved of some part of the burden of the increased cost of standardisation, since the Central Electricity Board was instrumental in securing Government Unemployment Assistance Grants, which have already relieved the industry of annual charges aggregating up to the end of 1938 £1·74 millions.

The benefits arising from standardisation are difficult to assess with any precision. The savings attributable to the Grid system, which are already substantial, could not have been on the same scale had standardisation not been undertaken, and, in addition, economies in the costs of production of transformers, motors, convertors, meters, and instruments are not inconsiderable, and must give rise to benefits to the undertakers, consumers, and manufacturers It is at least questionable, for instance, whether any considerable market for electrical clocks could have been developed if non-standard frequencies had persisted; while of much greater importance is the fact that national defence requirements have undoubtedly been simplified by the existence of a national standard-frequency basis.

Since the benefits of standardisation are so widely dispersed, it is appropriate that the costs should be spread over the whole of the supply industry. The maximum burden actually placed on the supply industry in any year has been 0·88 per cent. of the revenue from electricity sales, and the peak incidence has now been passed.

Operation and Maintenance of Grid Equipment

General.—A complex electrical system, erected at a cost to date of over £30 millions, can hardly be expected to be entirely free from faults. No fault is allowed to pass without the closest examination, and it can be claimed that in relation to the size of the system the number of faults is small. The overhead lines have proved their reliability in conditions of severity even in excess of those envisaged in the official Regulations, and it is noteworthy that no 132-kV tower has been destroyed or even seriously damaged by natural agencies. The numerous high towers for river crossings, canal overbuilds, and multiple-circuit towers, are individual achievements in structural engineering which have proved entirely satisfactory.

Steel-Cored Aluminium Conductors

The conductors have proved suitable for all classes of line. There have been jointing troubles, necessitating new types of joint, and vibration experience has led to the general precautionary fitting of anti-vibration dampers. In certain small areas, corrosion led the Board to use suitable protective coatings, but on over 99 per cent. of the total length of lines aluminium deterioration is less than 1 per cent. per annum for the outer layer and still less for the inner, while only a few insignificant instances of deterioration of the galvanised steel core have as yet been encountered.

Insulation.—In many areas of Great Britain high-voltage insulation suffers exceptionally from industrial pollution and fog prevalence, and although the standard line insulators proved eminently satisfactory on about 90 per cent. of the system, for the more vulnerable sections of line special insulators had to be developed. Lightning remains the most frequent cause of faults on overhead equipment, being responsible during the last six years for an annual average per 1000 miles in service of about nine flashovers on 132-kV lines and 34 on lower-voltage lines. Fortunately, the effects on reliability of supply are not great and damage to transformer insulation, involving lengthy repairs, has been too infrequent to justify the fitting of protective devices except in areas specially prone to lightning.

Bushings for transformers, circuit-breakers, metal-clad switchgear, and the like have been remarkably free from trouble. Condenser bushing insulators have shown three general types of weakness—ingress of moisture, surface tracking, and puncturing due to internal voids. The remedial improvements, though sufficiently obvious in general terms, require technical skill of a high order, and I record with appreciation that all manufacturers involved have loyally co-operated in the work of rectification.

High specific insulation stress necessitates appropriate testing methods, involving the measurement and examination of the variation of dielectric losses and currents with applied voltages and temperatures. In certain circumstances X-ray examination is also useful.

Transformers.—In 1927, small low-voltage transformers had self-contained on-load ratio-changing gear in only a few exceptional cases. The decision so to fit all Grid transformers has been shown by experience to be wise. Almost every high-voltage transformer in the supply industry is now fitted with such gear as standard practice, with large consequent savings. This change in general policy is sufficient indication of the complete technical success of the Grid equipment, by which British transformer manufacturers made an impressive contribution to electrical engineering, all the more praiseworthy as every unit has to be transportable over British railways with their restricted loading gauge.

While research into surge phenomena in this country may have lagged behind that of other countries in the past, the Board has done much to assist and accelerate British investigation, in collaboration with the British Electrical and Allied Industries Research Association and the National Physical Laboratory, and I consider Great Britain to be well to the fore to-day. It should be possible in the reasonably near future to assess accurately the stresses imposed on transformer windings by lightning, and so to design windings and protective devices that service failures may be eliminated.

Switchgear.—The Board's equipment is believed to constitute the largest installation of switchgear operated by one management. In 1927 it was obvious that great changes in circuit-breaking technique were pending, but construction could not be delayed until these matured, and experience indicated no undue hazard in using the then existing types of circuit-breaker, suitably modified to meet the higher voltage conditions.

Short-circuit testing has been in progress for some years and there are now five large testing stations in this country. This testing has resulted in greatly improved safety and increased speed of clearance of faults. Arc-control devices have made possible the renovation of many older types of circuit-breaker to give performance almost comparable with that of the most modern productions. The relations between the short-circuit conditions imposed by test plants and those encountered in supply service are not yet fully understood, but I hope and anticipate that the necessary co-operation between supply authorities and manufacturers, already commenced, will expand until all outstanding questions have been satisfactorily answered.

Cables.—Owing to the wide extent of built-up areas in this country, extensive sections of high-voltage cables had to be used for Grid connections to selected and other stations, the system to-day comprising 23¼ route miles of 132-kV cables and nearly 200 miles at lower voltages. When it is remembered that in 1927 there was practically no experience of 66-kV and 132-kV cables in this or any other country, this work of the British cable makers, of which little has been made public, will be realised as one of the greatest achievements ever accomplished in cable construction and installation.

Every encouragement and opportunity have been given to manufacturers to prove under service conditions any cable having an adequate background of properly controlled works testing. This policy has resulted in healthy technical rivalry in a field where at one time the tendency seemed to be towards monopoly. I will not venture to prophesy which of the rival high-voltage cable systems is likely to predominate; the oil-filled cable has a long start against its more modern rival, the internal gas-pressure cable, but the latter has constructional and technical advantages which force consideration by all potential users of very high-voltage cable.

Protective Equipment.—Although used where practicable, the adoption of pilot-wire protection throughout the system was impracticable, since the necessary pilots would have cost some £3½ millions; in general, reliance had to be placed on the now well-known impedance and reactance types of distance protection. For the year 1938, correct operation of the protective gear as a whole reached a figure of 88 per cent., and certain of the areas attained the excellent standard of 96 per cent., which is probably about the maximum attainable with existing equipment and without expenditure disproportionate to the gain to be derived.

Of great promise in overhead-line protection is the development by which power lines themselves are used as pilots for conveying high-frequency tripping or locking impulses.

Metering.—Special forms of integrating meters, summators, maximum-demand indicators, and printometers had to be developed to measure and record with the requisite accuracy the various electrical quantities required by the complicated accountancy of the 1926 Act. The British Meter Manufacturers responded to this need and produced the necessary instruments in what now seems a remarkably short period. The metering equipments have given such excellent service that disputes between the Board and authorized undertakers on the subject of measurements have been negligible. From both personal and technical standpoints it is significant that even in the few controversial cases reference to an outside standardising authority has not been necessary.

Inductive Co-ordination.—There is now extensive experience of the effects of the Grid system on the communication systems of the Post Office, the railway companies, and other important bodies, and I am glad to be able to record no appreciable trouble on the communication systems, interference of either transient or continuous types having been almost non-existent. This satisfactory result has been secured by continuous co-operation between the respective technical staffs. Radio interference problems have also been dealt with on co-operative lines.

System Operation

System Control.—The Board rent from the Post Office, for exclusive use, an extensive network comprising over 5000 radial miles of communication channels. The service standard provided by the Post Office is a high one, and the provision and maintenance of this system by specialists leave the Board's staff free to concentrate on their own problems of power supply.

The Grid is grouped into seven operational areas, each having a control centre conveniently situated in relation to the Board's District Office. An overriding National Control has been introduced to co-ordinate the work of these seven Control Centres when inter-area operation is in force. For lengthy periods during last year the whole Grid was run in parallel, without incident, with a maximum load on the interconnected power stations of the order of 6,730,000 kW.

Frequency Control.—Frequency and time control is carried out from the Control Centres themselves, since with a comparatively large number of stations running in parallel, and with interconnectors of limited capacity, it is necessary to vary simultaneously the outputs of quite a number of stations, in order to obtain the desired alterations of Grid frequency.

There is no doubt that the maintenance of a high standard of frequency control is a valuable safety precaution for meeting emergency conditions.

It is appropriate here to refer to a service so far rendered by power interests free of charge, namely the provision of electrical time. To the great majority of users the present standard of time-keeping is adequate, and the use of synchronous clocks has consequently extended very rapidly. There are, however, certain users who would like a higher degree of accuracy, and it must be made clear that the primary objective in operating power systems in this country is continuity of supply; the second is economy of production; accuracy of time-keeping is relatively not nearly so important, and no statutory requirement whatever charges the Board or any other authorised undertaker with the duty of time-keeping.

Fortunately for time-users, however, maximum efficiency of production, constant frequency, and correct time-keeping are rigidly related by the fundamental principles of power production, and as we progress towards ideal operating efficiency we shall concurrently tend to satisfy even astronomers with the degree of agreement between Greenwich time and what we may justifiably call "Grid time."

As a word of warning, time-keeping, although now identical over hundreds of square miles, is not normally identical over the whole country, as the Grid is customarily operated in two or three sections. In such conditions there may be a slight divergence between the separated sections in phase and frequency, which might embarrass persons such as television experimenters wishing to depend on Grid supplies as a standard of exact time reference.

System Stability.—Actual experience of the electrical stability of the Grid under normal working conditions has been most reassuring. The Grid is not a simple transmission system transferring large blocks of energy over long distances from generating station to load centres, and its extended busbar characteristics favour stability; even when inter-area operation on a large scale is in force, there is no sign of instability provided the majority of the Grid lines are kept in service.

British alternators of more or less normal design have proved reasonably stable under Grid operating conditions, even during severe faults. Turbine governors have given practically no trouble, although in the case of some of the larger machines installed prior to Grid operation it is doubtful whether, if full load were thrown off, the running governor could keep the maximum variation in speed below the trip speed of the emergency governor. The throwing off of full load does not often occur; but if it does, every minute is valuable, and if the emergency governor

operates, considerable inconvenience may be caused by the time and trouble required to bring the machine back to normal conditions ready for load. The difficulties involved are fully realised, but I feel sure that British manufacturers will not fail to find a satisfactory solution of this minor problem.

Effects of Control on Efficiency.—The first beneficial effect to be anticipated from the establishment of the Grid was a reduction in the plant capacity required to cover a given power demand. During the pre-Grid period the amount of spare plant to provide against possible breakdowns had been increasing steadily with the rising size of plant units. Future plant extensions will be proportionate to the rate of growth of load, but savings under this head will continue, since at all stages of growth a smaller volume of plant is required under Grid conditions.

Apart from the saving in capital charges, the Grid makes possible the allocation of load in accordance with cost efficiency, enabling the selected stations most efficient from the works-costs point of view to be run for long periods and the least efficient to be relegated to peak-load duty.

Extensions of Generating Capacity

Procedure.—The onus of initiating all new plant proposals in connection with selected stations is now placed upon the Board. For the orderly fulfilment of this duty, plant-extension programmes are drafted by the Board in the spring of each year for each of the seven operating areas of the Grid. These extend for four winters ahead in the case of extensions to existing stations, and for five winters ahead in the case of construction of new stations.

The prediction of load growth over these extended periods is a matter of some difficulty and major importance. In preparing the plant-extension programmes, the Board obtain estimates from the individual undertakers of their probable load requirement over the period in question. These individual estimates are supplemented by independent area estimates made by the Board, based on the general principles of analysing separately the potentialities of each of the main classes of load, with allowance for probable future trade conditions.

After the estimate of the load to be met has been formed, a decision is then taken on the margin of spare plant to be provided, and in this connection the Board has the valuable assistance of the Consultative Technical Committee set up in each of the areas.

The guiding principle in determining the location of additional generating capacity is to combine reliability of supply with maximum economy in the combined costs of production and transmission, and the advantages of locating stations at favourable generating sites have to be balanced against costs and hazards in transmitting their output to the load centres.

The general adoption of higher steam temperatures and pressures is rapidly diminishing the relative difference in cost efficiency between stations with abundant cooling water and those with cooling towers. Broadly speaking, riverside stations have the lowest capital costs, followed by cooling-tower stations, while stations on coastal estuaries have the highest capital costs owing to the expensive civil engineering work required. With modern high-efficiency cooling towers, re-cooled temperatures of 75 deg., 70 deg., and even 65 deg. Fah. are possible in the average hygrometric conditions obtaining in this country of 51 deg. Fah. wet-bulb temperature, when working on cooling ranges of 14 deg. down to 10 deg. Fah., and in these circumstances a cooling-tower station may be designed for an average annual thermal efficiency very little lower than that at a riverside site, enabling future plant to be more closely located in relation to load centres, with very substantial consequential savings in transmission.

Development in Plant Design.—The Board has endeavoured to avoid any action tending to stereotype design and have done everything possible to encourage design development on the part of both manufacturers and users.

During the part few years considerable investigation has been carried out in order to establish in practice the thermal gain from a change in the steam cycle, and some very interesting plants are now in operation or under construction in selected stations.

Considerable developments have also taken place since 1927 in boiler design, but time does not permit of any adequate review of these, although mention must be made of the special types of forced and natural circulation boilers which are being tried out by authorised undertakers in this country at the present time. These developments would make very interesting papers by themselves and I hope that The Institution may have the benefit of such papers in the near future.

Boiler Availability.—The establishment of the Grid has drawn attention to the influence of boiler availability on capital and operating costs. There is a wide gap between the average availability of turbo-alternators and boilers, and every effort should be made to ensure better boiler availability and thus avoid capital locked up in the boiler house lying idle for long periods of the year.

Investigations have shown that where high gas velocities had been employed in the economiser and air-heater sections of the boiler, rapid fouling occurred with certain brands of coal, and in certain cases the pressure-drop increased by 10 per cent. in under 400 hours' service.

In the more recent types of boilers, the adoption of larger combustion chambers, coupled with an increase in the amount of heat absorption by radiation in the combustion chamber and a reduction in the amount absorbed in the convection passes of the boiler, has led to some improvement in availability, and recent experience gained on a high-head type of stoker-fired boiler shows that after 2500 hours' continuous service, during which fourteen different brands of coal were used, it was still possible to obtain 25 per cent. overload, although the gas passes had been cleaned by soot blowers only. This is a marked improvement, which I hope will be followed up by boiler designers and lead to still better results.

Treatment of Flue Gases.—Systematic and large-scale investigation in this country into the problems of comprehensive flue-gas treatment only dates from 1927, when the first definite requirement to remove sulphur compounds from flue gases was imposed on an electricity supply undertaking. Two large existing selected stations have already been required to be equipped with sulphur-extraction plant, and in some other cases provision has had to be made in the design for the subsequent addition of such plant if necessary.

When it is realised that the provision of gas-washing plant of the types now in use may increase the capital costs of a station by as much as £2 per kW, may add some 0·02d. per unit to the works costs of generation, may increase the consumption of energy in auxiliaries by about 1 per cent. of the generated units, and may reduce boiler availability by about one-sixth, it will be seen that the addition of the gas-washing equipment at present available constitutes a serious burden on the industry. Here is a subject giving ample scope to the engineer and chemist, for there is urgent need for investigation and research, with the object of developing systems which will ensure some commercial return on combustion by-products commensurate with the costs involved in gas-washing.

Hydro-electric Selected Stations.—The foregoing refers to steam-driven generating plant at selected stations, but the Grid made possible the development of the Galloway water-power scheme, which, although only accounting for little more than 1 per cent. of the energy consumed in Great Britain, is of much technical interest. The natural water-power resources of the area could not have been effectively utilised in the customary way, and the Grid gave exactly the outlet required for the potential power. The scheme was formulated by the late Mr. William McLellan, and it is greatly to be regretted that he did not survive to witness the successful culmination of a scheme which, in all essential respects, was of his own creation.

Remodelling of Older Stations.—The national scheme as it now stands differs in one important particular from the original proposals. Whereas the Weir Committee contemplated that national needs could be met by a total of 58 selected stations, the Board found that certain stations not suitable for selection had some residue of useful economic life in association with the Grid, and in 1938 the Board had under direction the operation of no less than 171 stations, including 137 selected stations. In present circumstances the retention of these additional generating stations constitutes an asset of material value from a national point of view, since, apart from defence considerations, with spreading urbanisation suitable generating sites are increasingly difficult to secure.

Not all the sites still retained are suitable for re-development, since present-day needs have outgrown the capacity or suitability of the sites, but most of the older stations will still continue to give service under the Grid scheme. They have fulfilled useful peak-load functions up to now, and as the existing equipment is amortised many are being—and will be—reconstructed to give a good account of themselves in years to come.

With this end in view, a careful investigation of the site conditions at each station is in progress, it being most important so to plan reconstruction as to avoid any fall in capacity and yet to ensure that any extension shall form part of a comprehensive ultimate scheme of development. In many cases it has already been found possible, by the purchase of additional land, to envisage modelling the station up to three or four times the original designed capacity.

New Stations.—Even when advantage is taken of the re-development possibilities of all existing sites, the rate of growth of load is so rapid that already the Board have made definite arrangements for the provision of 12 new selected stations. If current trends continue, in the years that lie beyond 1942 many more new stations will be required, giving ample scope to engineers of the future for further development in the "scientific art" of economical electricity production.

Total Capacity.—The total national installed generating capacity in 1927 was approximately 5·2 million kW. Since that date there has been installed, ordered, or approved for installation up to the year 1942, under arrangements made by the Board, a total of some 5·7 million kW, involving a capital expenditure of approximately £81½ millions, which is almost three times the capital expenditure on the original Grid.

It will be seen that arranging for the provision of additional generating plant is now one of the major activities of the Board, and will be of increasing importance until such time as the rate of growth of demand upon the supply industry slackens.

It is not too much to say that the Grid has brought about a revolution in the outlook regarding the provision of new generating equipment. Indeed, the co-ordination of generating plant development may well prove ultimately to be the greatest of the contributions of the Grid towards the advancement of the supply industry. Previously, new generating facilities were provided piecemeal as required by the load increment of the individual undertakings, and the size and type of set were more or less rigidly determined by local load prospects in the years immediately ahead.

Within those limitations, a steady increase in plant efficiency was ensured by the consent of the Electricity Commissioners to the installation of new plant, the progressive outlook of the responsible engineers, and the healthy rivalry between the manufacturers of different types of plant. While these factors continue to play their part, the establishment of the Grid has introduced a completely new factor, since it enables planning to be carried out on a radically wider and more logical basis than was possible under isolated operation.

Conclusion.—The success from a national viewpoint which has been, and is still being, achieved by the Grid policy is a great tribute to the co-operative spirit prevailing in the supply industry, in which all the authorised undertakers concerned have played a worthy part. With their loyal co-operation, a state of organisation has already been accomplished on the generation side of the industry which is without parallel in any other country of the world.

I cannot close this survey without paying my meed of tribute to the work of so many scientists who have helped in the creation of this national asset. The extension of applied science into the various industrial laboratories and Research Associations has done much to solve our problems, and some of the finest brains in the country are now engaged in such centres. To such workers the electrical industry owes a real debt of gratitude.

Looking back on this brief review of the progress made since 1927 with the Grid scheme, and of the outlook for the future, I am satisfied that we have in our national electrical industry all the components required to provide the user of electricity with the best possible service. I see no easy path to completely trouble-free electrical service, nor do I fail to realise that the supply industry has technical and organisation problems which still await solution. But I do see much scope for the labours of adaptable and imaginative engineers. The part to be played by The Institution, in improving and developing the personnel and equipment required by our great industry and in furthering the cause of international engineering co-operation, is both onerous and honourable, and it will be my pleasure and privilege to assist in the task during my period of office as President.

I enter upon that period at a time when, unfortunately, science is debased for war purposes, instead of promoting goodwill and friendship between nations. But although others may for a time disturb the pursuit of knowledge, scientists throughout the world form a great brotherhood, united by a common aim, a common quest for knowledge. Kingsley long ago expressed the democratic basis upon which this fellowship is founded. "If," he said, "you want a ground of brotherhood with men, not merely in these islands, but in America, on the Continent—in a word, all over the world—such as rank, wealth, fashion, or other artificial arrangement of the world cannot give and cannot take away, join the freemasonry in which Michael Faraday, the poor bookbinder's boy, became the companion and friend of the noblest and most learned upon earth, looked up to by them not as equal merely, but as teacher and guide, because philosopher and discoverer."

Operations at Unfenced Machinery

The recent Report of the Chief Inspector of Factories observes that "there has been a tendency to overlook the restricted scope of the Operations at Unfenced Machinery Regulations and to regard 'machinery attendants' as being licensed to do work other than that prescribed; work which involves a contravention of the statute and would entail serious liability should an accident occur." The Regulations do *not*, as some people imagine, make it right for every kind of work to be carried out on unfenced moving machinery, provided that it is done by a certified person. Only *certain* work is permitted. To make the matter clearer the National Safety First Association suggests the following test questions in regard to any proposed operation.

1. Is it an examination which must be carried out while the part is in motion ? *or*

2. Is it lubrication or adjustment, which (*a*) is shown by such examination to be immediately necessary *and* (*b*) must be done while the part is in motion ? *or*

3. Is it (*a*) lubrication of or shipping or mounting of belts on transmission machinery used in one of the fifteen processes scheduled in the Operations at Unfenced Machinery Regulations *and* is it (*b*) work which cannot be deferred until the machinery is stopped ?

If one of these three questions cannot be answered unreservedly in the affirmative, the operation proposed is not legal.—*Industrial Safety Bulletin.*

Rail and Road

THE KHYBER TRUNK ROAD.—As part of its road building programme the Afghan Government has sanctioned the expenditure of 50 million rupees (Afghanis) for the repairing of the trunk road from Khyber to the Bolan Pass.

MANUFACTURE OF LOCOMOTIVES IN INDIA.—Two railway officers are to prepare estimates of the expenditure necessary to equip suitable railway workshops for the manufacture of locomotives. The estimates are to be placed before the Standing Finance Committee early next year. It is also announced that the Railway Board proposes to appoint officers to examine the possibility of constructing broad gauge engines on a limited scale in one of the existing State-owned railway workshops.

INDIAN STATE RAILWAYS.—The permanent financial committee of the Indian State Railways agreed the investment programme of about 150 million rupees for the financial year 1939–40. From this sum about 50 million rupees are provided for the purchase of rolling stock, 81 million rupees for repairs and improvements of the superstructure, stations, and bridges, 8·5 million rupees for the construction of three secondary lines in the Province of Sind, and 0·5 million rupees for the purchase of machines for the railway workshops in Parel and Ajmer.

AMMONIA AS AN ENGINE FUEL.—The use of ammonia as an engine fuel is described in the French publication *La Science et la Vie:* the liquid ammonia is vaporised and then passes over a catalyst which causes between 5–10 per cent. of the vapour to be decomposed into hydrogen. This hydrogen acts as a primer to the combustion. According to the Phillips Petroleum Corporation, a 6 per cent. addition of liquid ammonia to ordinary petrol raises the permissible compression ratio appreciably. Moreover, the lead susceptibility of the petrol is markedly increased in the presence of ammonia.

BAKERLOO TUBE EXTENSION.—On Monday, November 20th, the extension of the Bakerloo tube to Wembley Park and Stanmore will be opened for traffic. This extension is one of those included in the great programme of new works now being carried out by the London Passenger Transport Board at a total cost of about £40,000,000. It establishes for the first time a direct link between the Metropolitan Line and the West End of London, making it possible for passengers from the Wembley Park and Stanmore areas to travel without change to Piccadilly and Charing Cross, and passengers from more distant stations to change at Finchley Road simply by crossing a platform. When the line is opened the new tube stations, St. John's Wood and Swiss Cottage, will also come into use.

BRITISH ROAD FEDERATION.—At the emergency meeting of the Committee of Management of the British Road Federation, it was unanimously agreed that Mr. F. G. Bristow should be asked to act as Honorary Secretary of the British Road Federation for the time being, in order that the activities of the Federation might be carried on to the fullest possible extent under present conditions. It is intended that the Federation shall continue its activities dealing with issues that concern the welfare of all sections of the Road Transport Industry and its subsidiary interests, in accordance with past policy. It is also intended that a close watch be kept with regard to its policy concerning better roads, in order that it may continue to press for road improvement whenever it is deemed fit and practical to do so.

LOWER S.A. IMPORTS OF MOTOR CARS.—New motor vehicles licensed in the Union of South Africa in August were:—Motor cars, 2241; motor buses, lorries, trucks, and vans, 762; motor cycles, 152. Of the motor cars, 2181 were from the United States, 306 from the United Kingdom, and 254 from other countries. Of the motor buses 704 were from the United States, 37 from the United Kingdom, and 21 from other countries. Of the motor cycles, 118 were from the United Kingdom and 33 from other countries. The total import of motor vehicles has dropped considerably compared with the figures for the corresponding month in the last few years. It is noticeable that motor cars from Britain have maintained their numbers, but the monopoly in motor cycles which Britain has held for a number of years seems hardly as complete as it used to be.

METHANE GAS FOR MOTOR FUEL.—The Middlesex County Council has approved a scheme for the using of surplus methane gas from the sewage works at Mogden for motor transport vehicles. It is stated that a steady surplus of over 150,000 cubic feet a day of methane gas was being produced at Mogden, and the intention is to instal two compressors for storing the gas in cylinders. Estimates show that 300,000 gallons of petrol a year will be saved. At a recent meeting of the South Wales Institute of Engineers, Mr. Ivor Graham proposed that the large natural resources of methane in the coalfields of this country, which are in many instances tapped and piped out of the mines in order to get rid of it as a nuisance, might be utilised for motor transport. He considered that the withdrawal of the gas from the pit could be carried out with perfect safety to works in the pit if control apparatus was provided. The gas might be collected on the surface in large gasholders or stored under pressure.

AUTOMATIC TRAIN CONTROL ON THE G.W.R.—The Great Western Railway Company announces that with the fitting of the last ramp at Penzance on Thursday, November 9th, the scheme of installing its own system of automatic train control throughout the 2852 miles of main line routes between Paddington and Penzance, Fishguard, and Chester has been completed. The system was invented by members of the G.W.R. staff. It enables the engine driver to receive an audible warning in his cab as to the position of each caution signal about to be passed. If the line is clear a bell rings by the driver's side, but if it is not clear, the signal is at caution, a siren blows, and the brakes are automatically applied throughout the train. Tests have proved that at 60 m.p.h. a train can be brought smoothly and automatically to a standstill in 900 yards or 450 yards before reaching the "stop" signal. The cost of carrying out the scheme is in the region of £250,000, and has necessitated the fitting of 3250 engines and installing 2114 ramps to the track.

Miscellanea

ELECTRICAL INSPECTOR OF MINES.—The Secretary for Mines announces the appointment of Mr. G. M. Harvey, the Deputy Electrical Inspector of Mines, to be the Electrical Inspector of Mines, with effect from November 1st, in succession to Mr. J. A. B. Horsley.

SEVERN CATCHMENT BOARD.—As the Government regards the work of Catchment Boards essential to its agricultural campaign, the Severn Catchment Board has decided to complete its approved schemes. A marked beneficial effect has been observed since the completion of the stone training wall at Lower Parting, early in August, and tendencies to head up the west channel and erode the west bank have been eliminated.

MACHINING OF COPPER.—A new publication of the Copper Development Association deals with the machining of copper and its alloys. The first section of the book classifies the various copper alloys and gives their mechanical and general machining properties. Later chapters summarise modern machining practice and the selection of copper alloys for machining purposes. Copies of the book may be obtained free of charge from the association's offices at Thames House, Millbank, London, S.W.1.

THE JUNIOR INSTITUTION OF ENGINEERS (INCORPORATED).—The Right Honourable the Viscount Falmouth, who was President-Elect of the Junior Institution of Engineers, suggested to the Council that, as it would be impossible to hold the Inaugural Meeting at which the new President delivers his Address, it would be best if the President continued in office for the duration of the War. The Council approached Sir Charles H. Bressey, the present President, and he has consented to continue as President for the year 1939–40.

PIG IRON GRADING SCHEME.—The British Cast Iron Research Association has issued a special publication on its pig iron grading scheme. This scheme provides a series of grades into which the various types of British pig and refined irons can be arranged on a basis of chemical composition. Its object is to indicate to users of these irons what compositions are normally available and give the limits of composition of each grade. The publication is obtainable, at 2s. 6d. net, from the Association's offices at 21–23, St. Paul's Square, Birmingham.

INCREASE IN THE PRICE OF COAL.—In accordance with the undertaking given to the Government by the Central Council of Colliery Owners that the general level of pit-head prices would not be raised without prior consultation and agreement with the Government, the Central Council has submitted an application for an increase to cover wages additions operating from November 1st and certain increased costs of production arising from war conditions. The application has been investigated by independent accountants appointed by the Government and, based upon their report, an increase of 1s. per ton for England and Scotland, and 1s. 4d. for Wales has been agreed.

TREATMENT FOR ROT-PROOFING SANDBAG REVETMENTS.—We are informed by the Ministry of Home Security that on the basis of present information two types of preservative are considered to be suitable for application to sandbag revetments. They are respectively a creosote or tar distillate, used as a water emulsion, or a solution of an organic copper salt in creosote made up into an emulsion. The former is more widely available than the latter and is suitable for treatment of revetments in position which have already deteriorated by being exposed to the weather for some time. The latter is more potent but is also more expensive, and its use will not generally be justified unless the bags are in good condition, and unless it is desirable to take down the whole revetment, treat all the bags, and then repile them.

A SUBSTITUTE FOR MICA.—In a mineral markets report of the United States Bureau of Mines there appears the following note:—"For many years, the statement could be made confidently that mica was one of the few minerals for which no acceptable substitute was available in many of its principal uses. In 1938, this statement was challenged by the discovery of Alsifilm. This product, made from bentonite, has not yet come out of the laboratory, but its appearance on the market, possibly this year, will be watched eagerly. Still another new development is the possible use of ground mica for certain of the uses of sheet mica or splittings. Japan is rumoured to have made advances in this field, and an American inventor has applied for patents and has disclosed his plans to Bureau of Mines Engineers."

A NEW GLASS.—In the United States, the Corning Glass Works has developed a glass which can be heated until it glows and then plunged into ice-cold water without breaking. It consists of about 96 per cent silica and is said to be comparable in most respects except cost to fused quartz articles. The process consists of forming an article from a modified Pyrex glass melt, heat treating to separate the constituents of the glass into two phases, dissolving out one phase containing most of the flux, and then fusing the remainder to give a clear, transparent product, free from bubbles, and undistorted by shrinkage. The material has a coefficient of linear expansion of only some 40 per cent more than that of fused quartz. It may be used at temperatures up to 1000 deg. Cent. and has exceptional electrical insulating properties.

CORDUROY USED FOR GOLD RECOVERY.—The recovery or saving of gold and gold-bearing minerals on corduroy is described in a report recently issued by the United States Bureau of Mines. The use of fibrous materials for catching gold at placers and in milling plants is old practice which had been more or less discarded. Of late it has again come into extensive use. The corduroy from which wearing apparel is made is unsuitable for saving gold, but a special weave with the threads or fibres cut is made for the purpose. If gold does not amalgamate readily, or is associated with sulphides, or the ore is acidic making the mill water acid, corduroy will catch the valuable minerals, whereas mercury-coated copper plates will not do so. The report includes a description and pictures of corduroy, how to use it, and how to treat the gold and heavy minerals caught thereon.

Air and Water

FORMATION OF STEVEDORE BATTALIONS.—Special stevedore battalions of the Royal Engineers are now being formed in connection with the discharge of ships at the Army's base ports overseas.

THE "THETIS."—A team of miners, experienced in rescue work, has succeeded in removing thirty-four bodies from the sealed stern compartment of the submarine "Thetis." It was found necessary to cut away the bulkhead door by oxy-acetylene burners.

MERCHANT SHIPPING WAR CASUALTIES.—From the beginning of the war up to November 6th, fifty-six British vessels aggregating 238,795 tons, seven allied ships aggregating 47,935 tons, and thirty-two neutral ships aggregating 88,485 tons had been lost.

BRITISH PATROL VESSEL LOST.—The Admiralty recently announced that H.M.S. "Northern Rover" was considerably overdue and must be presumed lost. She was a 188ft. long, 655-ton trawler, which had been taken over by the Navy. Her crew comprised four officers and twenty-three ratings.

NEUTRAL CIVIL AIRCRAFT.—Approval has been given for the neutral civil aircraft which are shortly to fly between Britain, Sweden, and Norway to be painted orange, to distinguish them from military aircraft. The service is to be operated by the Swedish company, A.B. Aero-Transport, and the Norwegian company, Det Norske Luftfartselskant.

LOSS OF H.M. SUBMARINE "OXLEY."—The First Lord of the Admiralty has announced the loss of H.M. Submarine "Oxley" as the result of an accidental explosion. This 1354-ton vessel was built in 1926 for the Royal Australian Navy and was presented to this country in 1931 as an economy measure. She carried four officers and fifty-four men.

A FLOATING DOCK FOR STOCKHOLM.—A subsidy has been granted by the Swedish Government for the construction of a floating dock at Stockholm. Amongst the conditions attached to the granting of the subsidy is that the dock shall be able to handle vessels up to 8000 tons, it shall be 470ft. long, and that if possible it shall be completed before the end of 1941. The subsidy granted amounts to 600,000 kroner.

THE MINISTRY OF SHIPPING.—Sir John Gilmour, replying to a question in the House of Commons, said that the staff at the headquarters of the Ministry of Shipping numbered 822 exclusive of messengers and cleaners. Of these, 699 were civil servants prior to their appointment to the Ministry; 515 of them were employed before the outbreak of war in the Board of Trade on work now transferred to the Ministry of Shipping. The remainder included 40 persons from the shipping industry with specialist experience.

THE BRITISH SHIPBUILDING PROGRAMME.—The Minister of Shipping was recently asked in Parliament whether, in view of the serious reduction in British shipbuilding capacity as a result of the activities of the National Shipbuilders Security, Ltd., he could state the measures contemplated by the Ministry to increase the productive capacity of the industry. He replied that he had a programme of shipbuilding in hand and restrictions on yards previously regarded as redundant will not be a limiting factor in that programme.

LABOUR SUPPLY IN THE SHIPBUILDING INDUSTRY.—The Ministry of Labour and National Service announces that representatives of the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions recently took part in a conference at the Ministry of Labour and National Service with representatives of that Ministry, the Ministry of Shipping, and of the three Service Departments. There was full discussion of the relationship between the labour supply in the industry and the requirements of the Services for tradesmen. Further discussions are being arranged.

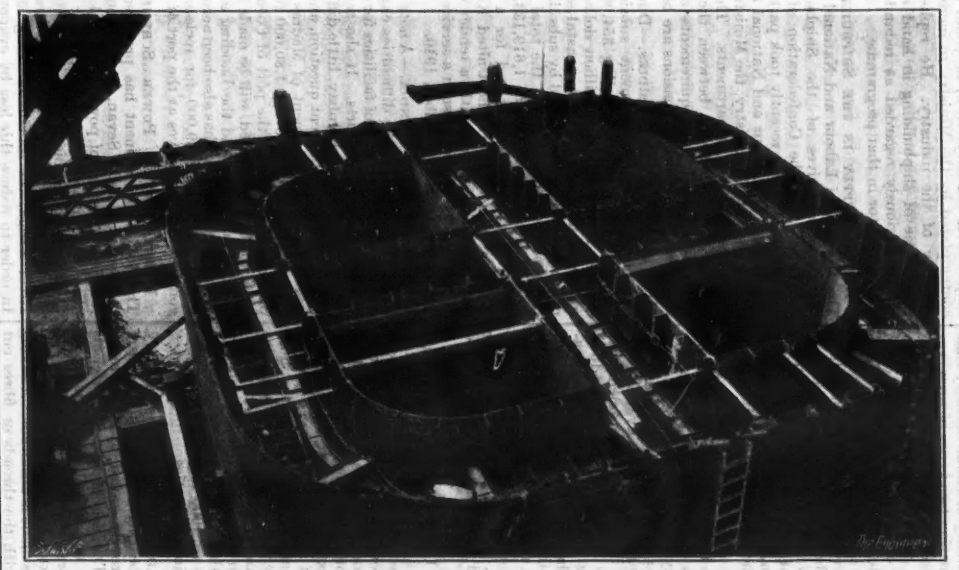
CANADIAN SHIPPING SUBSIDIES.—During the year 1938–39 the Canadian Government subsidised its Atlantic shipping with a sum exceeding 354,000 dollars. Pacific services received over a million dollars and nearly two million dollars was spent on coastal services. The total number of passengers carried by subsidised services during the year was 218,893; and the total number of tons of freight carried amounted to 1,619,133. During the year a call for tenders was issued for a subsidised service between Prince Rupert, the United Kingdom, and/or the Continent, and subsequently a tender was accepted and a contract entered into for such a service. This service will probably start in September, 1940.

A NEW DRY DOCK IN INDIA.—A note in *Indian Engineering* says that one of the difficulties experienced in Indian coastal ports is the lack of facilities for dry docking vessels which call at those ports. If the terminal port of the vessel is Calcutta or Bombay, little difficulty arises, but in other cases it is a different question, and it is interesting to hear that the Government of Madras has sanctioned an estimate amounting to Rs. 1,80,000 for the construction of a new dry dock at the port of Cocanada. Equal contributions, it is reported, will be made from the Provincial Minor Ports Fund and the Landing and Shipping Fund, Cocanada. Sanction has also been accorded to an estimate amounting to Rs. 69,000 for reclaiming areas for the construction of wharves at the port of Cocanada.

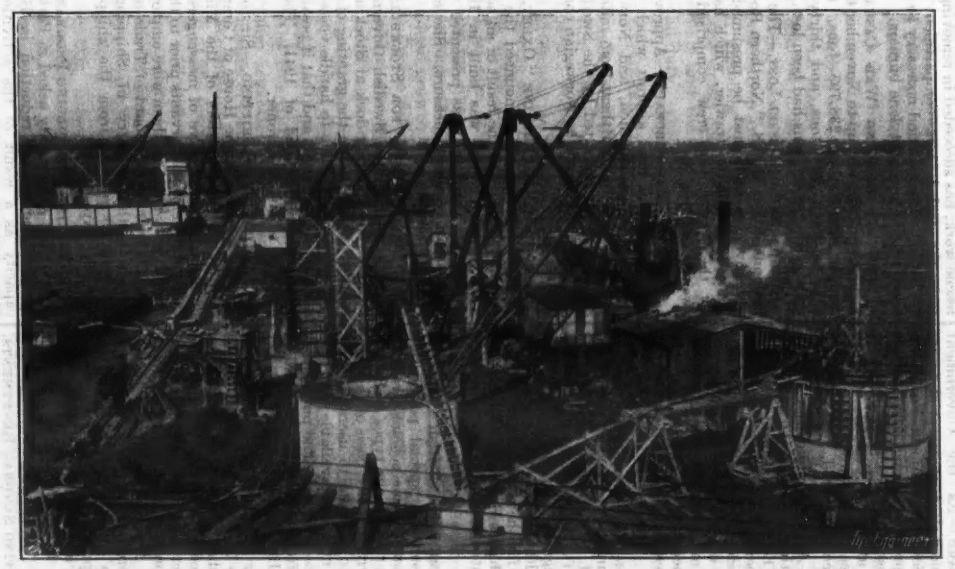
HYDRO-ELECTRIC POWER SCHEME IN ARMENIA.—The Soviet Government has prepared a scheme to use the waters of Lake Sevan, in the mountains of Armenia, for the generation of power. The lake covers an area of about 580 square miles and each year it is estimated that 24,720 million cubic feet of water drain into the lake, of which only a small portion is drained away by the River Zanga, the remainder being lost by evaporation. In order to reduce this loss by evaporation it is planned to lower the lake level by 164ft. A tunnel some four miles long will carry the water to an underground hydro-electric station. From this station the water will pass on to power stations at Karavan, Gyumush, Arzni, Kanakir, and Erevan. Near Arnzi a large irrigation reservoir is to be formed to serve the neighbouring districts.

ERECTION OF BRONX-WHITESTONE BRIDGE, NEW YORK

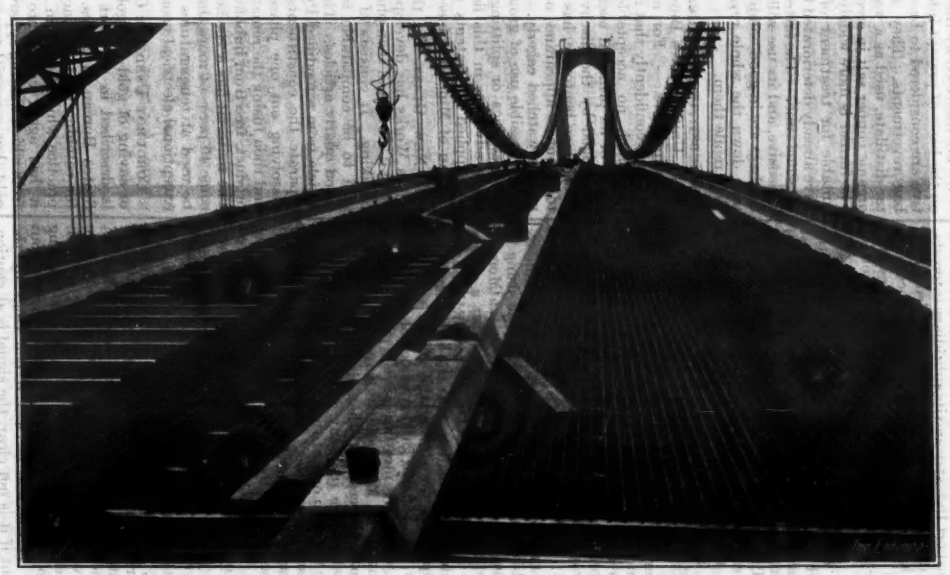
(*For description see page 487*)



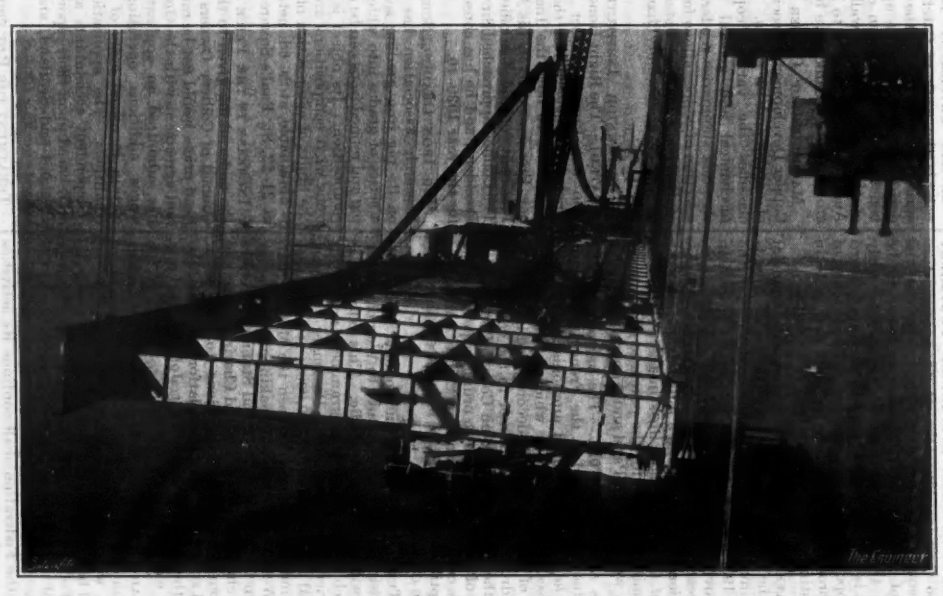
FLOATING STEEL CAISSON FOR QUEEN'S SIDE TOWER



WORK IN PROGRESS AT QUEEN'S ANCHORAGE



REINFORCEMENT FOR DECK CONCRETE



CONSTRUCTION OF DECK

The Engineer

NOVEMBER 17, 1939

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THE WAR AT SEA

ON September 27th—as reported in our issue of October 6th—Mr. Winston Churchill made his first statement on the progress of the war at sea. It covered a period of twenty-four days, and showed that the German attempts to dislocate our sea-borne trade were a failure, and that the toll of the U boats was very high. On Wednesday, November 8th, the First Lord presented the second instalment of his serial. A little grimmer in tone, as of one settling down to a long and stern struggle, it was in substance as satisfactory as that which preceded it. He told the Commons that between two and four U boats were being sunk week by week, that our hunters are being increased three times in number, that the total loss of the British mercantile marine tonnage is less than one-third of one per cent., and that overseas traffic is being carried on without much reduction of volume. He warned the country that great and serious losses in our fighting and mercantile services must still be expected, but he expressed confidence that we had the upper hand of the enemy, and that although the end might still be far off, the issue was not in doubt. "We shall break their hearts."

It is interesting to contrast the candour of Mr. Churchill's statement with the reticence and *suppressio veri* of German ministers. The First Lord made no attempt to minimise or palliate the loss of the "Royal Oak." He admitted that the Admiralty and the Navy were responsible. A long period of immunity, partly a heritage of the Great War, had made them less watchful than they should have been. A door had been left slightly ajar, and for reasons concerned with fleet activities, the number of patrol craft had been reduced. The commander of the German submarine found the opening and took his chance. Even after the first attack the officers of the "Royal Oak" did not believe that she was torpedoed. Danger from the air was apprehended and the watch was sent to its air-raid quarters—under armour. It was then that the submarine fired several torpedoes, blowing the sides in, and the men were trapped so that the loss of life was very great. It has been asked why a ship with "bulges" was sunk by torpedo attack. The answer is, we suggest, clear. No conceivable bulge would be proof against what Mr. Churchill described as a salvo. Deeply as the country deplores the loss of a fine ship—although she was old she had been reconditioned—and more than eight hundred lives, the balance between the strength of the German and British Navy is altered by hardly a grain. As the First Lord said, we should be prepared to take on the whole German fleet with no more than the ships which the Nazis claim to have sunk! The statement revealed also that we had lost a submarine through an accidental explosion. The "Oxley," and her sister the "Otway," were completed in 1927 for the Royal Australian Navy, and were presented to the Royal Navy in 1931. She was a large vessel of her type, and her normal complement was fifty-four officers and ratings. The casualty list shows that fifty-three lives were lost. The publication of the mishap was deemed inadvisable at the time, and its date is still unrecorded. All that the First Lord said was that it had occurred since the "outbreak of war." When the known and surmised activities of the Navy are remembered, the loss of three ships, the "Courageous," "Royal Oak," and "Oxley," by enemy attack in ten weeks of active war cannot be condemned as an excessive payment. Only now and then is the public told of naval events, as when a unit is lost as at Scapa, or an attack repelled as at Rosyth, or a convoy defended successfully against air raiders, but it does not forget that all day long and all night the ships of the King, big and little, are about their business in constant danger and in a state of constant vigilance and alertness. It is rather a matter for admiration and congratulation than for censure that in these months of constant personal strain there have been so few mishaps, and one must endorse wholeheartedly the decision of the Admiralty to make no judicial enquiry into the loss of the "Royal Oak" with a view to assigning blame to individuals. As Mr. Churchill said, "Such a course would impose an additional burden upon those who, afloat and ashore, are engaged in an intense and deadly, and, as many may have well thought, not wholly unsuccessful struggle."

From this dark side of the war at sea we turn to the First Lord's report of naval activities against the submarines. In the second four weeks of the war, British tonnage lost by enemy action—72,000 tons—was less than half that lost in the first four weeks. More than ten million tons of cargo were brought into this country in the first eight weeks of the war, and over 400,000 tons of cargo consigned to Germany were captured. Even finer achievements are promised. The convoy system is not yet working to full efficiency, and several hundred of our largest ships have been withdrawn temporarily to be given defensive armament. These figures show unchallengeably the magnificence of the efforts which the Navy is making to protect merchant shipping from submarine attack. But it is also, in conjunction with the Air, destroying submarines at a rate which amounts on a conservative estimate to between two and four in every week. When many U boats are out there are more losses to shipping, but there are also more targets for our hunters. Hence, variations in the number of victims occur. To keep pace with her losses it appears probable that Germany, according to the First Lord, is producing two new U boats every week, and that she may have as many as one hundred available in January. In our article of October 6th we referred to the likelihood that Germany was fabricating submarines as she did in the Great War. Mr. Churchill's estimate would seem to give substance to that probability. It is far from unlikely that for some years past Germany has been accumulating submarine engines and accessories, and perhaps even getting hull and structural parts ready for assembly. Here again we are not unprepared. If Germany opens the New Year with more U boats afloat than she had at sea in September, she will find three times as many hunting craft searching for them. Let her increase her attacks if she can, her losses will increase in greater proportion, and though she may hasten the output of material she cannot hasten effectually the output of trained officers and men. The time will come when the supply fails and when the hearts of crews are broken by the ordeal. "A conflict," said Mr. Churchill, "from which perhaps one in four of each excursion never returns, and the others with grievous experiences, is one which must have in it many deterrent factors." However our enemy may struggle to maintain the output of U boats, the incessant depletion of man power must tell sooner or later. The officers and crews of the U boats command our admiration. Their lot is a terrible one, and the duty that they are bidden to fulfil is repugnant to many of them. The nervous strain to which they are constantly subjected is enormous by comparison with that of the hunters and of hunted merchantmen. But even if men of iron nerve can be found in sufficient number to man a hundred boats, their training cannot be accomplished in a week or two, and if they put to sea uneducated in the handling of submarines their early fate will be sealed.

In the fighting and invigorating speech which Mr. Churchill broadcast on Sunday night he added nothing of moment to what he had told the House of Commons a few days before. His subject was "Ten Weeks of the War," and he took a new line for Cabinet orators. There was no trace of "appeasement" in his words, but defiance and determination. Much as it departed from the reasoning and calmness of other orations we are disposed to think it was well timed. In these interminable weeks of waiting for major events the general public have begun almost to doubt if there is "a war on" and if it has a concrete enemy. Mr. Churchill reminded his millions of hearers that tremendous events may happen at any moment, and that we must not relax our efforts by a particle or iota. The period of waiting might be trying and even boring, but it had been profitable to the British Empire, which was far stronger now than it was ten weeks ago. Our Navy had increased in strength and readiness; the anti-U boat campaign was succeeding; we had three times as many hunters as we had. Two thousand five hundred of our ships were constantly at sea, whilst those of the enemy were rusting in neutral harbours. The German Fleet refused to be drawn into action with our North Sea Fleet. In the air we were accumulating strength, and the defences against raids in this country had been greatly increased. The Empire's Expeditionary Force had consolidated its position, and the training of officers and men was proceeding apace under the unexpected calm of the Western Front. In all this Mr. Churchill showed that whilst the dullness of this "gentlemanly" war (as someone has called it) was only apparent the fact was that not a moment of the lull had been wasted, and that events and activities that must affect the progress and issue of this struggle had been continued without ceasing. The defiant tone which Mr. Churchill adopted may perhaps be regarded as the visible sign of the buoyancy of spirit with which his knowledge of the position had inspired him. It is well that the peoples of the Empire should share this spirit, for it will foster and encourage their resolution to pursue the war, whatever disappointments, sorrows, and distresses it may have in store, in the certainty that in the end the peace and liberty of the whole world, for which they are fighting, will be won.

The Maximum Effort

UNDER to-day's conditions, war demands an ever-increasing supply of armaments and equipment of every kind, and one fighting man fully equipped is worth more than ten men without

essential arms and supplies; the fate of Poland surely gives evidence enough of this fact. The task of producing military equipment falls mainly on the engineering industry, and although its output has been greatly increased in face of many difficulties, yet it is still not giving the maximum production of which it is capable, because under present circumstances sufficient labour is not available to keep its machines running to full capacity by night as well as by day. It is true that in many establishments night-shifts are already being worked, but in almost every instance they are relatively small, and it is probable that something like half of the machine tools already in existence are idle at night.

Machine tool makers are being inundated with orders for new machines to the extent of millions of pounds, and, what is even more serious, millions of pounds' worth of machines are being imported at a time when the problem of foreign exchange is becoming increasingly acute. Labour must, of course, be found for all the masses of new machines which are daily being installed, but surely it is self-evident that labour should first be found to operate continuously those thousands of machines which are already available. In times of pressure the advantages of running full night-shifts are obviously very great: no capital expenditure is required and increased production is attained almost immediately, because existing organisations are employed, and because the elaborate and costly jigs and fixtures, which take so long to produce, need not be duplicated. The necessary labour for bringing the night-shifts up to full strength exists, but in present conditions it is not available, and can only be made immediately available by broad-scale agreements between the Government and Trade Unions to suspend for the period of the war all restrictions on the employment of women and young male persons, whether by day or by night, and by the whole-hearted acceptance of the principle of dilution without the tedious and complex local procedure which is now required and which renders rapid progress impossible. Labour has shown itself so fully in accord with the Government in the energetic prosecution of the war as to justify the hope that further concessions will be made, if the urgency of the situation is clearly recognised. It may be asked how the employment of women and semi-skilled and unskilled workers can increase the supply of skilled labour for which the present demand is so urgent and the training of which is such a lengthy process, but it must be realised that large numbers of skilled workmen are engaged on work which can quite well be done by less experienced operatives. A skilled workman may be defined as one who is competent to do *any work* within that branch of the trade to which he belongs. But, owing to the sub-division of processes in large-scale production, unskilled or semi-skilled labour can quickly be taught to perform many of the simple processes now carried out by fully qualified men, and these skilled men can be rendered available for the constantly increasing volume of really skilled work for which they are urgently needed. Regarding women's work, experience taught us during the last war a great deal about the value of their services in engineering. There have been many arguments as to what really constitutes women's work, but the true definition is, firstly, that it must be within their physical capacity, and, secondly, that it must be work which they can in fact accomplish satisfactorily. In modern engineering, particularly of the lighter kind, there are endless jobs of a repetition character which women can be taught to do with speed and accuracy. On some of the finest processes, such as gauging and inspection, their more acute perception, coupled with their diligence and patience in monotonous tasks, make them invaluable. Women are already giving splendid work night and day in the many Auxiliary Services in connection with A.R.P., Army, and Air Force work. Why should not their full effort in mechanical work be employed? It may be objected that conditions in the workshops at night are less pleasant than by day. In normal times this is true, but now practically all our shops are darkened completely for air-raid precautions, and artificial light is used during the day, so the conditions in the shops are the same through the twenty-four hours, and, of course, wherever women are called upon to work by night, Welfare Supervisors of their own sex must be provided.

The fighting forces must be asked to recognise that their needs for equipment can only be met if they refrain from enlisting those young workers in the engineering shops, who are at present being taken by hundreds into the Army and other Forces at the very time when they have learned enough of their trade to be invaluable. The list of restrictions on the recruitment of young persons must be largely extended and at once. While in theory it is possible to get essential men returned to industry after they have joined the Forces, yet in practice it is very difficult if not impossible to do so. The shell shortage in the early stages of the last war is still a bitter memory, and we remember, too, that after many hesitations and delays this shortage was overcome mainly by the removal of restrictions on labour and by keeping production at its full pressure night and day. Surely the time has come for the removal of all handicaps. If they are removed now, the war can be shortened and thousands of lives and millions of pounds can be saved. Why should we wait till we are in the last ditch before taking action, the necessity for which is so obvious? Nothing but the Maximum Effort in industry will avail us, and that effort must be made without delay.

More About the Grid

Mr. Johnstone Wright's I.E.E. Presidential address published in abstract elsewhere in this issue, but not delivered on account of the war, deals naturally with the British Grid. As the new President is the Central Electricity Board's chief engineer this rather hackneyed subject was to be expected. From time to time the grid has been treated from all sorts of angles at I.E.E. meetings by those connected with it. In 1927, Sir Archibald Page described in his Presidential address what the scheme would do and what it would fail to accomplish. It would not, he said, appreciably improve the efficiency of generation in the areas of certain large undertakings, it would not reduce the price charged for lighting in large cities, nor would it create a new electric heaven or give "ninepence for fourpence." At the time the grid construction had only just begun. Subsequent contributions to the I.E.E. proceedings by members of the C.E.B. have considered various aspects of grid design and construction novel to this country. But the scheme is now an established entity and Mr. Johnstone Wright summarises some of the experiences gained and progress made.

Among the problems that had to be faced in the task of linking up generating stations was that of standardising frequency, originally estimated to cost 10½ million pounds. Many contended that the figure was too low. Discussing the matter in his I.E.E. Presidential address in 1925, the late Mr. Chattock stated that 27 million pounds would be nearer the mark. But according to Mr. Wright the actual expenditure up to 1938 when the work was practically complete, was 17·3 millions, part of which is recoverable as ante-dated expenditure subsequently needed to meet normal development. Had the decision to standardise been delayed to the present time, the cost would have been well over 30 million pounds. The savings attributable to interconnection could not have been on the same scale if frequency standardisation had not been adopted. In its absence stations working at a different number of cycles per second could only have been interconnected through frequency changers, involving additional losses and working inconvenience. The benefits arising from frequency standardisation are, as Mr. Wright says, difficult to assess with any degree of precision, but apart from the advantages of interconnection, economies in the cost of production of transformers, motors, converters, meters, and other instruments are believed to be not inconsiderable. Moreover, it is questionable, in the opinion of the author, whether any considerable market for electric clocks could have been developed if non-standard frequencies had persisted. Standardisation has undoubtedly facilitated the manufacture of these clocks, but electric time keeping would not have been possible at all without frequency control, which was initiated by the North Metropolitan Electric Supply Company before the grid came into existence. What effect the adoption of a single frequency has on the cost of the manufacture of motors, transformers, meters, etc., is also difficult to say. Most probably, the saving is not so great as is generally supposed. Non-standard plant and apparatus still have to be made for export and for private installation. Moreover, frequency is not the only item to be considered. Manufacturers still have to cater for a multiplicity of voltages and different types of supply. Until something much more approaching uniformity is attained on the distribution side of electricity undertakings in this country the industry will continue to labour under a disadvantage. Statistics issued by the Electricity Commissioners reveal the extent to which the supply industry still falls short of full technical standardisation. A statement issued some little time ago showed that according to the preliminary figures for 1937/1938 there were 19 different declared low pressures, and 293 undertakings were using non-standard voltages for the whole or part of their supplies. Of these 293 undertakings, 160 included some proportion of D.C. supplies. At the end of the year mentioned, there were 264 undertakings distributing both A.C and D.C. current. Hence the adoption of a standard frequency is but a step towards complete standardisation. The annoyance and expense suffered by a consumer, who, on changing his place of residence, finds that his electrical appliances and lamps have become obsolete, has often been emphasised. Official control has not as yet been extended to distribution. For the present, it is confined to generation, and there is no doubt that the grid has provided electrical manufacturers with much valuable experience. As shown in the address, considerable attention has been paid by them to insulation, transformers, switchgear, protection gear, and other electrical problems. Largely on account of conditions imposed by interconnection, switchgear design and testing have been revolutionised. Before the complete linking up of power stations was contemplated, on-load tap changing transformers of appreciable capacity were practically unknown in this country, but now almost every high voltage transformer in the supply industry is fitted with tap changing gear. Certain types of super tension cables would probably never have been brought to their present state of perfection had it not been for the grid. Oil-filled cables for super pressures were in use elsewhere before the scheme took practical form, but satisfactory gas-filled cables have since been developed by British manufacturers.

It scarcely need be said that the first beneficial effect to be anticipated from the establishment of the grid was a reduction in the plant capacity required to cover a given demand. Apart from the savings on capital charges, the grid makes possible the allocation of load in accordance with cost efficiency, enabling the more efficient stations, from the works cost point of view, to run for long periods and the least efficient to be relegated to peak load duty. Unfortunately the saving attributable to the increased efficiency has been largely offset by the rise in the price of fuel since 1935, although had it not been for the National Electricity Scheme an appreciable all-round increase in the charges for electrical energy could scarcely have been avoided. But notable as the advantages of the grid are shown to be, it must not be imagined that no substantial progress would have been made by electrical undertakings without it. There have always been progressive engineers. According to Mr. Wright, the Board has endeavoured to avoid any action tending to stereotype design and has done everything possible to encourage development on the part of manufacturers and users. With that policy none can disagree. To tie engineers down to any particular plant when engineering advances are constantly being made would indeed be a retrograde step, liable, we imagine, to lead to no small opposition.

Circulating Water, Heat Transmission, and Heat Discharge in Condensing Plants

By R. H. PARSONS

THERE is probably no major factor in power station operation concerning which the engineer feels so much uncertainty as he does regarding the quantity of water passing through his condensers at any time. The general lack of information on this subject is to be regretted for two reasons, firstly because it deprives the operator of the readiest means of verifying the condition of his condensers as regards cleanliness, and secondly because it leaves him with no check on the amount of heat being discharged from the generating units. The importance of the former consideration will be at once admitted, but the latter would seem to deserve more attention than is given to it. The temperature rise of the circulating water is easily measured, so that it is only necessary to know the quantity of water passing to determine the heat being carried away. In these days when every B.Th.U. in the coal has to be accounted for, it is certainly remarkable that something like half the output of heat should be discharged to the river or the sea without measurement. It may be because of an idea that this heat is no good anyway, so that the best thing to do is to get rid of it as cheaply as possible and then forget about it. This point of view, however, is not conducive to the most efficient operation of the plant. The heat discharged is so preponderant an item in the thermal balance sheet that even a small change in its amount for a given electrical output signifies a perceptible alteration in the overall efficiency of the station. Figures from a modern central station show that, under test conditions, some 28 B.Th.U. were converted into saleable electricity, and 52 B.Th.U. were carried away by the circulating water for every 100 B.Th.U. liberated in the furnaces. Assuming the losses in the boilerhouse and the heat consumption of the auxiliaries to remain unchanged, it follows that an increase of 2 per cent. in the heat discharged would leave rather less than 27 per cent. for conversion into electricity, so that the overall thermal efficiency would be reduced by more than 1 per cent. This would be of quite sufficient importance to call for investigation. It would, by hypothesis, be due to some deterioration in the performance of the generating machinery, which would be detectable at once if the quantity of heat discharged could be compared with the electrical output.

In the absence of any adequate means of metering the circulating water, it is usual to arrive at the amount passing through a condenser by comparing the temperature rise of the water with the heat estimated to be given up by the exhaust steam. For this method to be satisfactory it is necessary for the steam consumption of the turbine at the time to be accurately known, so that it is not convenient for general purposes. Moreover it obviously fails to serve as the required check upon the performance of the turbine, for it assumes a knowledge of the very fact that is at issue.

It has already been pointed out that the two principal reasons for requiring a knowledge of the quantity of circulating water are concerned with the efficiency of the condenser itself and with the rejection of heat by the prime mover. Both these matters depend ultimately upon temperature differences, and it will be shown that a solution to the problem of determining the amount of circulating water, and therefore to the questions of condenser cleanliness and heat discharge may be obtained from a consideration of the temperatures involved. The method of attack is an indirect one. The first step is to note the relationship between various factors given by the equation

$$K=\frac{Q}{S}\times\log_e\frac{(T_s-T_i)}{(T_s-T_o)} \quad . \quad . \quad (1)$$

This equation, or some equivalent of it, is well known to condenser designers and will be found in every text-book on the subject, so that there is no need to justify it here. It is sufficient to say that T_s denotes the temperature on the steam side of the tubes; T_i and T_o the temperatures of the circulating water at inlet and outlet respectively; S the surface of the condenser in square feet; Q the quantity of circulating water in lb. per hour; and K the coefficient of heat transmission, which is defined as the number of B.Th.U. passing through each square foot of tube surface per hour for every degree of temperature difference across the walls of the tubes.

In the case of any condenser actually at work, we can easily measure the three temperatures T_s, T_i, and T_o, and it may be presumed that the surface S is known. We are then left with the variables K and Q, neither of which can be determined without a knowledge of the other. We are able, however, to calculate the value of K for any given value of Q/S, which represents the number of pounds of cooling water per hour for every square foot of tube surface. It is more convenient to consider the water in gallons per minute (G) than in lb. per hour (Q), and since Q=600G, we may write

$$K'=600\log_e\frac{(T_s-T_i)}{(T_s-T_o)} \quad . \quad . \quad (2)$$

when K′ will represent the value of K for any condenser supplied with cooling water at the rate of one gallon per minute per square foot of tube surface.

Now this rate of water flow must correspond to some definite velocity of the water passing through the tubes of any given condenser. If we have full particulars of the condenser we can determine what this velocity is. Furthermore, if we knew the relationship between this velocity and the coefficient K, we should have sufficient information to calculate the numerical value G, which is what is required. Many formulæ have been suggested to represent the relationship between the velocity and K. One of the best is probably that given by Messrs. Guy and Winstanley in their paper on Surface Condensers read before the Institution of Mechanical Engineers in 1934. This formula is

$$K=650\times\sqrt{\frac{v}{5}}\times\sqrt[4]{\frac{T}{100}} \quad . \quad . \quad (3)$$

in which v denotes the velocity of the water through the tubes in feet per second, and T the arithmetical mean of the inlet and outlet temperatures in degrees Fahr. The arithmetical work involved in the transformation of this formula into a shape suitable for our present purpose is tedious, and it is sufficient to say that the final result works out as

$$K'=16{\cdot}8598\times\sqrt{\frac{C}{G}}\times\sqrt[4]{T} \quad . \quad (4)$$

in which K′, G, and T have the meanings already assigned, and C is a constant for any particular condenser. The value of C is to be obtained from the equation

$$C=\frac{N\times P\times l^2\times d^2}{(d-2t)^2} \quad . \quad . \quad (5)$$

where N is the total number of tubes, P the number of passes, l the length of the tubes in feet, d their external diameter in inches, and t their thickness in inches.

It will now be obvious that we can calculate the quantity of water flowing through the condenser from a knowledge of the three temperatures T_s, T_i and T_o, and the mechanical details of the condenser. To do this we have to calculate the value of K′ from equation (2), find the value of T from our knowledge of T_i and T_o, and the value of C from equation (5). Substituting these figures in equation (4), we are left with G as the only unknown quantity, and its value can then be easily determined. To avoid the necessity for the somewhat large amount of calculation involved in the above procedure, the nomograms Figs. (1) and (2) have been prepared. These are the graphical representations of equations (2) and (4). By their means the quantity of circulating water passing through any condenser at any time can be immediately found, provided that we have the requisite temperature readings and the particulars of the condenser concerned.

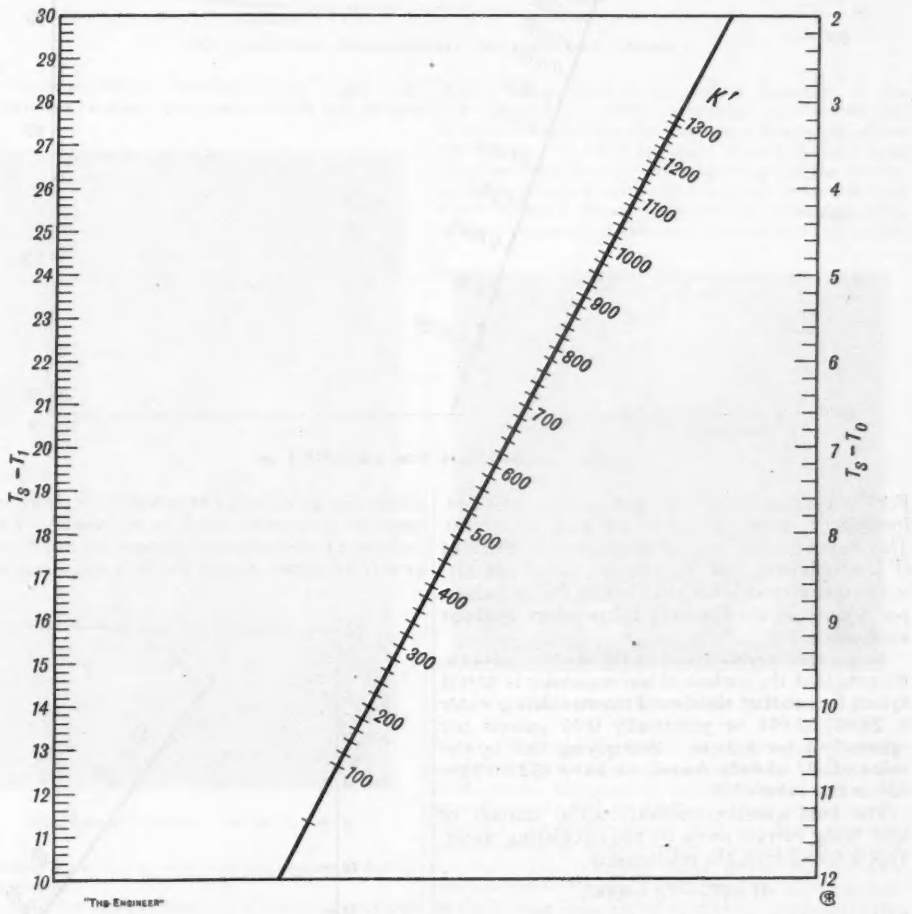


FIG. 1—NOMOGRAM FOR EQUATION (2)

The use of the nomograms can best be explained by an example. Suppose therefore that it is required to find the quantity of circulating water, the value of K, and the amount of heat being discharged from a condenser at some particular time. We will take a two-pass condenser of about 32,000 square feet of cooling surface, made up of 9180 tubes of 0·75in. external diameter, 0·048in. thick, and 17ft. long between the tube-plates, and will assume that at the time in question the temperature readings are as follows: T_s=79°, T_i=55°, and T_o=73°, so that (T_s-T_i)=24 and (T_s-T_o)=6. Marking the corresponding points on the side scales of Fig. 1, and joining these points by a straight line, it will be found that the line intersects the intermediate scale at K′=832. We know from the data given above that the mean temperature T of the circulating water is 64°.

Marking these values of K′ and T on the side scales of the second nomogram, and joining them by a straight line, we find that this line crosses the intermediate scale at the reading G′=0·0033.

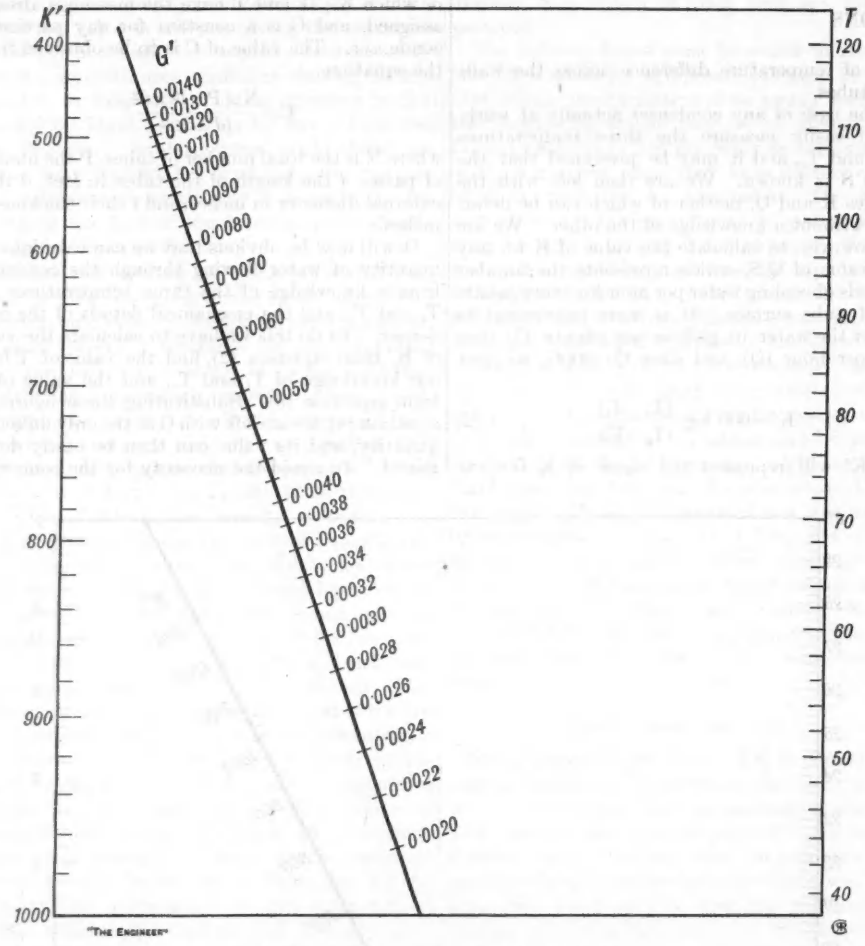


FIG. 2—NOMOGRAM FOR EQUATION (4)

For a condenser of the dimensions specified, formula (5) shows the value of C to be 7,290,000. This figure has to be multiplied by the value of G′ just obtained, and the product, namely 24,057, is the quantity of circulating water (G) in gallons per minute at the time the temperature readings were taken.

To get the value of K under the same conditions, we note that the surface of the condenser is 32,054 square feet, so that the flow of the circulating water is 24,057/32,054 or practically 0·75 gallons per square foot per minute. Multiplying this by the value of K′ already found, we have $832 \times 0{\cdot}75 = 624$ as the value of K.

The final question related to the amount of heat being carried away by the circulating water. This is found from the relationship

$$H=(T_o-T_i)\times 600G,$$

from which we see that $16 \times 600 \times 24{,}057$, or 220,947,200 B.Th.U. are being discharged every hour from the condenser under consideration.

The accuracy of the values of G, H, and K, as determined above will, of course, depend upon the validity of formula (3). This formula, it may be said, has passed the test of discussions by the Institution of Mechanical Engineers, and would no doubt be accepted generally as a satisfactory means of predicting the value of K for any design of condenser. As it has been found sufficiently accurate for this purpose equal reliance can of course be placed upon equation (4) which was derived from it by a purely arithmetical process, and the value of G can therefore be obtained with as much certainty as that of K for which formula (3) was primarily designed.

A few words may be added concerning nomogram Fig. 1. This may be used by itself as a ready means of observing any deterioration in the condition of a condenser, provided only that the quantity of circulating water does not vary. It is not necessary that the quantity should be known, but only that it should be the same every time that the nomogram is used. The circulating water employed in central stations is, in general, of a dirty nature, with the consequence that the condenser tubes become progressively fouler in service. The condensers, therefore, have to be laid off for periodical cleaning, which may be done either at regular intervals of time or after a given number of hours of operation, according to the practice of the station. Whichever system be adopted, there is no certainty that cleaning will either not be carried out before it is really necessary, or postponed until it is overdue, for the foulness of the tubes will depend as much on the quality of water during the interval as upon the amount of work done by the condenser. The direct result of dirty tubes is a corresponding reduction in the value of the heat transmission coefficient K. The actual value of this coefficient cannot be obtained from Fig. 1 alone, unless the quantity of circulating water is known, but for any given quantity of circulating water the values of K will be exactly proportional to those of K′. Hence the condition of the condenser may be determined with reference to the scale of K′ just as well as if this scale was calibrated in terms of K.

To observe the condition at any time, all that is necessary is to measure the three temperatures T_s, T_i, and T_o, and to draw a straight line across the chart connecting the points corresponding to (T_s-T_i) and (T_s-T_o) on the respective side scales. As the condenser becomes dirtier, the point of intersection of such a line with the K′ scale will become progressively lower, and when it reaches a predetermined low point it is time to take the condenser off for cleaning. The nomogram may be used in this way for ascertaining the condition of a condenser of any size, working at any load, and with any temperature of inlet water. The only requirement is that the quantity of circulating water should be the same on each occasion when a test is made.

Returning now to our original problem of determining the quantity of water flowing through an actual condenser, this may be approached by an alternative method. The quantity will evidently be related to the pressure drop necessary to cause the flow, so that if we observe the difference in head of the circulating water at entrance and at exit of the condenser, and if we know how the head depends upon the rate of flow, we have all the facts required for the solution of the problem.

In the book on "Steam Condensing Plant" by Mr. James Sim, it is shown that the total head across any condenser can be computed by the formula

$$H=P\left\{\frac{G^2 l}{3(3d_1)^5}+\left(\frac{G}{13d_1^2}\right)^2+0{\cdot}5\right\}+0{\cdot}5 \quad . \quad (6)$$

in which H denotes the head in feet; P the number of passes made by the circulating water; G the number of gallons of circulating water per minute; l the length of the tubes in feet, and d_1 the internal diameter of the tubes in inches. This formula is based on the work of Box, and the author, from his experience as Chief Condenser Designer to Messrs. J. and G. Weir, states that he has found it to give results in close agreement with observed figures. As it stands, the formula is of

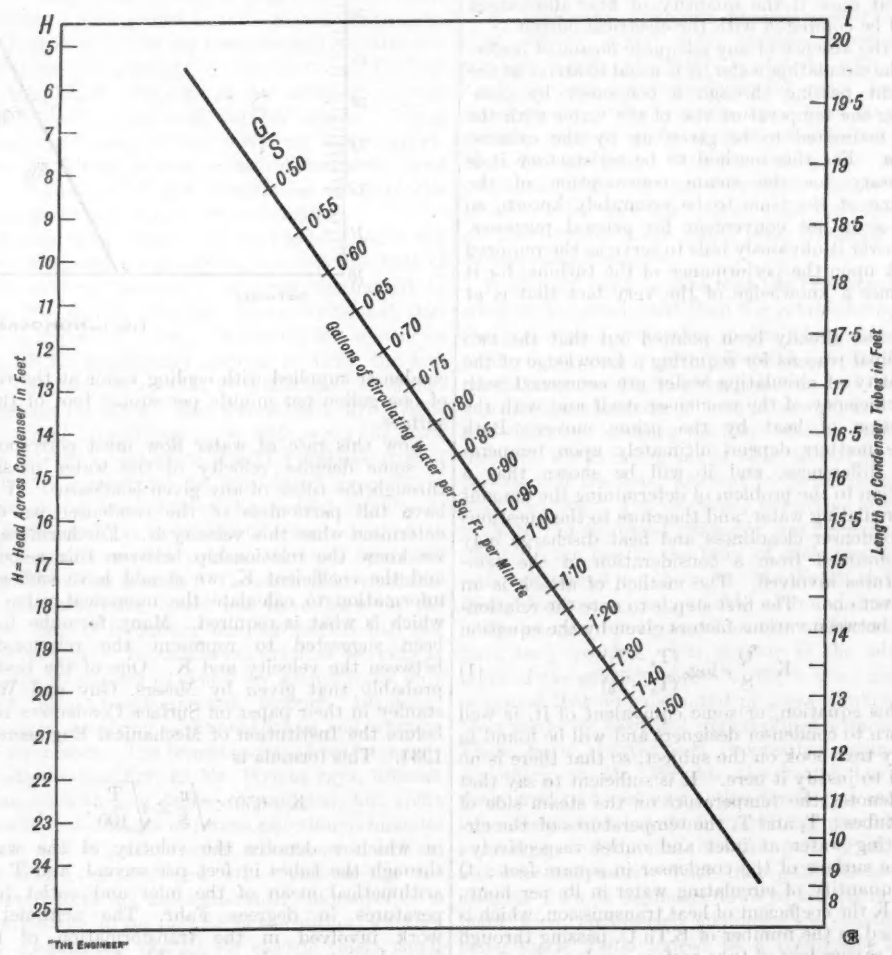


FIG. 3—NOMOGRAM FOR EQUATION (6)

more use to the designer than to the operator of condensing plant. The latter, however, may be presumed to know the surface of his condensers, and assuming such knowledge, the formula may be written

$$H-0{\cdot}5=\frac{G^2}{S^2}\times{\cdot}000094507\frac{P^3\times d^2\times l^2}{(d-2t)^4}\left\{\frac{l}{d-2t}+{\cdot}41343\right\}+0{\cdot}5P \quad . \quad (7)$$

in which d denotes the external diameter of the tubes in inches, and the other symbols have the meanings already assigned. When applied to any given condenser, of which the number of passes, and the diameter and thickness of the tubes are known, the formula is naturally simplified. For example, in the case of a two-pass condenser, with tubes 0·75in. external diameter and No. 18 gauge, it becomes

$$H-1{\cdot}5=\frac{G^2}{S^2}\times({\cdot}003554l^3+{\cdot}01l^2) \quad . \quad (8)$$

This formula is illustrated by nomogram Fig. 3. The latter enables the operator of any ordinary two-pass condenser fitted with 0·75in. tubes of No. 18 gauge, to determine at once the number of gallons of circulating water per square feet per minute (G/S) from a knowledge of the head across the condenser and the length of the tubes. All that he has to do is to draw a straight line across the chart so as to connect the appropriate points on the scales of H and l, and the intersection of this line with the inclined scale will give the rate of water flow. The determination of the value of G/S in this way allows the true value of K to be derived from nomogram (1), while the multiplication of G/S by the known surface of the condenser gives immediately the number of gallons of water flowing through it per minute.

The Norwegian Firefloat "Nokk"

In the accompanying engravings we illustrate the Norwegian firefloat "Nøkk" which has recently been constructed by the A/S Rosenberg Mek Verksted of Stavanger, Norway, to replace the old steam-driven firefloat, which has now served the Municipality of Stavanger for over half a century. The new ship is of special interest to our readers since the engines for propelling and pumping were designed and supplied by Gleniffer Engines, Ltd., of Anniesland, Glasgow, and mark a further development of the machinery which was supplied by the same firm for the Thames firefloat the "Massey Shaw," which was built by J. Samuel White and Co., Ltd., of East Cowes, and has been in the service of the London County Council for the past four years.

The "Nøkk" has been constructed in accordance with the highest classification requirements of the Norsk Veritas for a sea-going vessel, and is well fitted to protect an extensive sea front such as called for by her scheduled duty. She is equipped with a towing hook and horse, and besides being complete with the most modern fire-fighting facilities, is also equipped for salvage work. The principal hull dimensions of the ship and the particulars of her propelling and pumping plant are as follows:

Hull Dimensions

Overall Length	29 m.
Beam	5·6 m.
Draught	2·1 m.
Trial Speed	11½ knots

Machinery Particulars

Type of propelling machinery	Twin-screw Gleniffer oil engines
Designed output of each engine	160 B.H.P.
Running speed	900 r.p.m.
Number of cylinders each engine	eight.
Cylinder bore	6in.
Stroke	7in.
Reduction gear ratio	2 : 1
Diameter of propellers	45in.
Type of Pumping machinery	Two Gleniffer oil engine driven pumps
Designed output each engine	240 B.H.P.
Number of cylinders	Twelve
Bore of cylinders	6in.
Stroke	7in.
Running speed	900 r.p.m.
Output of each pump	7000 litres per minute
Normal delivery head	10 kg. per sq. cm.
Maximum delivery head	15 kg. per sq. cm.
Number of auxiliary sets	Two
Type	14 B.H.P. Lister engines
Generator voltage	115 volts

One air compressor and one general service pump driven by auxiliary generating set engines.

In the accompanying drawing (Fig. 1) we show a general arrangement drawing of the ship and her machinery, while in Fig. 2 a view is given of the "Nøkk" travelling at full speed discharging three 50 mm. diameter jets of water into the air from her three monitor fittings which are furnished with worm gear for both swing and elevation movement. As will be seen from our illustration they are placed one forward and one aft of the wheelhouse and one on the top of the wheelhouse on the bridge deck. In addition, on the after-deck and forward are groups of connections for six hoses, while on the starboard side of the same deck the salvage connections are arranged. Other deck machinery includes a hand-operated capstan aft and a double hand winch forward.

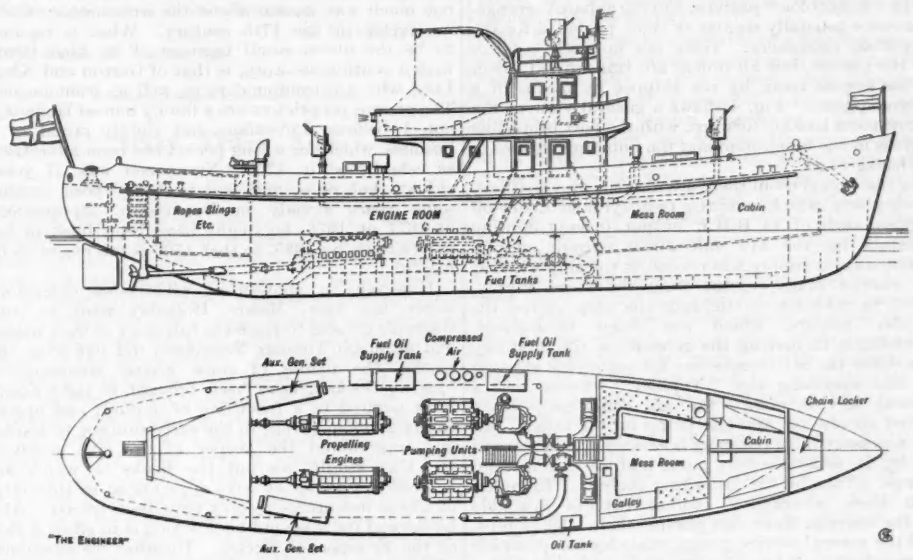


FIG. 1—GENERAL ARRANGEMENT OF FIREFLOAT "NOKK"

The accommodation is forward of the engine room and consists of a mess room with a table and seating and a galley for cooking, with sleeping accommodation further forward.

FIG. 2—THE "NOKK" IN ACTION

A view of the stern of the ship which we reproduce in Fig. 3 shows the arrangement of the two 45-in. diameter propellers and their "A" brackets, also the rudder gear. The stern gear is all bronze and the shafts are supported in cutlass bearings in the "A" brackets. This engraving also shows the exhaust outlets from the engines. The larger of the outlets, the two outer openings on each side are from the Gleniffer eight-cylinder propelling and the twelve-cylinder pumping units, and are wet exhausts with water injection silencers, the exhaust pipes consisting of a combination of armoured rubber and light alloy metal. The engine controls are of the latest Gleniffer mechanical pattern and are arranged on deck in the wheel house, with control columns of the type which were shown, it will be recalled, at last year's marine section of the Motor Show. The revolution counters are also arranged in the wheelhouse near to the control columns. The pumping units, driven by the two twelve-cylinder V type Gleniffer engines, were supplied by the Eureka Mek. Verksted of Oslo; as shown in the

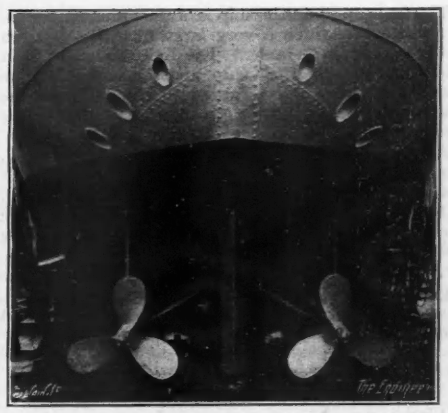


FIG. 3—PROPELLERS AND RUDDER

FIG. 4—THE ENGINE ROOM

accompanying table each pump has a designed output of 7000 litres per minute when pumping against a head of 10 kg. per sq. cm., but is able to sustain a working pressure of up to 15 kg. per sq. cm. The couplings between the engines and the pumps are of the "Silentbloc" pattern, and the exhaust arrangements are generally similar to those provided for the propelling machinery. There are no deck controls for the pumps, but all orders are transmitted direct to the engine room by the skipper by means of a Laryngaphone. Fig. 4 shows a general view of the engine room looking forward, with the port propelling engines in the foreground and the pumping engines in the background.

In the engine room there are also the two auxiliary lighting sets, which comprise twin-cylinder Lister oil engines, each of 14 B.H.P. output, driving lighting dynamos for the 115 volt direct current supply. Direct current supply was chosen as the ship when at her station takes current from the shore supply, which in addition to lighting the ship serves the tubular heaters, which are fitted throughout. In addition to driving the generators, the auxiliary sets drive the air compressor for supplying starting air and operating the "Typhon" whistle, and a general service pump, the air compressor being placed on one set and the pump on the other. All the necessary bilge pumping is arranged to be carried out by the general service pump and the engine room pumps, driven by the propelling engines. There are thus three alternative cooling circuits available for the engines, their own pumps, their bilge pumps, and the general service pump, while for the pumping engines there are two circuits, their own pumps and the general service pump. In order to preserve a cool hull when the ship is exposed to fire, small bore pipes are led along the gunwales with hoses on the outside. By this means a supply of water is fed to the outer plating of the hull, both on the port and the starboard sides, or one side as may be needed.

As shown on the accompanying plan, the sleeping accommodation which is provided is limited, there being two bunks and the settees in the cabin. In the cabin full provision for cooking and serving meals is provided.

The fuel supply in the ship is of the order of 10 tons, in addition to which a very large quantity of fresh water is carried in tanks. The fuel tanks are built into the structure of the ship, and the engine bearers and seatings are erected on the tank top. During the official trials of the "Nøkk" a speed of 11½ knots was attained.

Among those present at the trials were Mr. W. Ploon, M.N.I.F., of Oslo, the Consulting Engineer for the owners; the City Engineer, Mr. R. L. Juell, M.N.I.F.; Firechief S. Evensen, M.N.I.F., Stavanger; Director Thorwaldsen and Mr. Helleman, representing the builders of the ship; and Mr. T. W. Graff of Oslo, Mr. S. Arstad of Stavanger, and representatives of the engine builders. The trials were, we are informed, most successful, and the ship was immediately handed over to the Municipality of Stavanger.

Thomas Newcomen—Ironmonger

By W. A. YOUNG*

SOME persons seem to think that the purpose of this Society is to "laud and magnify" Thomas Newcomen, the inventor of the first practical steam engine. Yet we are no hero worshippers, and our ambit is the whole field of engineering and industrial history. That we should dwell upon the ways and works of our titular head—what little we know of them—is reasonable, and one thing we do not forget is that he was an ironmonger in his native town of Dartmouth. Your President this year started life in the business of an ironmonger, and has, therefore, chosen for his theme on this occasion that phase of Newcomen's career.

Having said that, I hope you will permit me to follow a somewhat personal line. Research into the history of the ironmongery trade has been desultory in character and the results have never been brought within the covers of a single book, perhaps for the sufficiently good reason that there would be no market for such a work. Yet in the ironmonger's shop may have been laid the very foundation of the mechanical engineering shop. It is recognised that the millwrights were the practical men who did the constructional work, but the material fashioned by them in the past was mainly wood, and they depended for manufactured supplies upon the ironmonger. Nowhere was there a more likely place in which to work out experimentally an invention such as the steam engine, than in an ironmonger's shop of the period. There an inventor would find a forge, a bench, craftsmen who could turn their hand to many things, and, not least important, stock from which to draw supplies.

What exactly are the known facts about Newcomen up to the time he began trading in Dartmouth? Little enough: he was born there in 1663 and christened on February 28th. I am not now concerned with his ancestry, or even his parents. What is known of them has been printed in the *Transactions*,† and we rely upon Mr. Lidstone of Dartmouth for the statement that he served his time with an ironmonger in Exeter, a likely city to which a West Country family in middle-class circumstances would send their son. Until quite recently, not much was known about the ironmongery trade in Exeter in the 17th century. What is reputed to be the oldest retail business of its kind there, with a continuous story, is that of Garton and King, Ltd., who are ironfounders as well as ironmongers. The present proprietors are a family named Holladay, not, I believe, Devonians, but rightly proud of a business which for a long period has been advertised as established in 1700. Newcomen was 37 years old at that date, and had probably been trading some years already in Dartmouth. Apprenticed in 1677 or 1678, he might have been back in his native town by 1685, so that 1700 is too recent to be helpful.

However, in connection with some extensions begun last year, Messrs. Holladay went to considerable trouble to trace the full story of their house, and although Thomas Newcomen did not cross the tracks, the names of some Exeter ironmongers, long overlooked, have been brought to light again. That pointed to a fresh line of inquiry, and opportunity serving, I went in the early summer to Exeter and interviewed the keeper of the city archives. Mr. Gay kindly got out the books in which are entered the names of boys apprenticed in that city, of whose indentures records have been traced. Also he showed me a second book which is in effect a Roll of the Freemen of Exeter. Together we examined all the entries covering the years 1660-1740, but the only reference to a Newcomen was in 1737, when John Newcomen was admitted a freeman by apprenticeship to a fuller.

Mr. Gay suggested inquiry of Mr. Burnet Morris of Teignmouth, who, he said, had an index of names of men and of their interests which ran into many thousands. I wrote to Mr. Morris, who replied, giving me a resumé of the Lidstone story which has already appeared in the *Transactions*. He added:—"If there is no reference to Newcomen in the Exeter Corporation's Book No. 55 (Freemen's Roll) which extends to 1696, it looks as if Lidstone had been mistaken about the place of apprenticeship." Mr. Morris suggested a search at the Rooms of the Society of Genealogists, Chaucer House, Malet Place, London, W.C.1, but he was afraid their general list of apprentices began in 1710. Inquiry there revealed the fact that the information the Society has is not classified and an inquirer must make his own search. Mr. Rhys Jenkins does not regard as hopeful this possible source of information.

Exeter anyway seems now to be a closed door, and in the meantime another suggestion was, "Try Totnes." I had planned to go to Plymouth last month, but the outbreak of war precluded the trip, and with it a halt on the way home. The Hon. Secretary of the Totnes Antiquarian Society is Mr. G. E. Windeatt, 19, High Street, Totnes. I place these names and addresses on record in the hope that in happier times inquiries may be set on foot by one of our Members.

The inquiries in Exeter have established the fact that in 1661 John Atkin was admitted a freeman of the City of Exeter, having served his apprenticeship with an Exeter ironmonger named Thomas Dixe. Freeman Atkin started on his own account in the parish of St. Petrock. His successor was John Southcombe, whose niece, in the manner so usual in those days, married Lewis Portbury, one of her uncle's apprentices. In 1708, sixteen years later, Portbury took over the business Atkin had founded. This, at any rate, puts two ironmongers, both possibly contemporary with Newcomen, in the Exeter calendar. It follows that Garton and King, Ltd., who now own the business founded by John Atkin are not only the oldest ironmongery house in Exeter, but perhaps in the whole country.

The business in Cambridge—where I had served my time—goes back to 1688 and perhaps further, and a third, nearly as old, is that of W. C. Till, Ltd., of Battle, Sussex, which dates from 1710. My own long contact with the ironmongery trade has led me to conclude that these three businesses have longer continuous connections with it than any others.

What kind of trade did these ironmongers do? What did they sell, and who supplied them with what they stocked and distributed? How did they get those stocks from their sources, and what was the method of payment? Pertinent questions, but not easy to answer! My own early training in one of the three businesses mentioned suggested the thought that I might re-create something of the background against which Newcomen worked.

He was 25 years old when William Finch went from Dudley, Worcs., to Cambridge, and took over from "Widow Godfrey" a business which has been continued since. Whether the widow's husband had been an ironmonger cannot be proved, but William Finch was, and the Finch family controlled the business down to 1847, when the last of the name was followed by his nephew, Swann Hurrell, whom I knew well, for he continued to live in the Foundry House after the business was taken over by his own nephew—Edward Beales. In my day the foundry was on the banks of the Cam, in Thompson's Lane, but before that it had been in a yard off Bridge Street; St. John's College Chapel was built on the site. There are several cast iron bridges in Cambridge which were made by the Finch family, one bearing the date 1826.

Edward Beales failed to maintain the traditions of his house, and in 1884 the late Alexander Macintosh acquired the business and transferred his own stock from Market Street to the more central shop in the Market Place. The founder of that business in 1816 was William Macintosh, who was a brazier and coppersmith. I can recall the old forge in the cellar in Market Street at which he tinned the utensils he made for the College kitchens. Here may I suggest that the connection between ironmongery and braziery was very close in the past. The Colleges meant a great deal to the coppersmith in Cambridge, because all the cooking utensils, down to my own day, were of the metal indicated, and I have had plenty of evidence since that tinned copper was used everywhere by persons of substance. The other available materials were cast iron and tinplate, but the "county" favoured copper and sent their pots and pans to their country market town where, at the ironmonger's, would be a coppersmith, or a tinsmith, who would repair them when necessary and re-tin the inner surfaces. I cannot imagine Newcomen going outside his own shop to get his experimental boilers and condensing cylinders made.

[Mr. Young's address then continued with a review of the history of several ancient ironmongery firms which, if it does not add to our actual knowledge of Newcomen, helps us to visualise the atmosphere in which he worked.]

Institution of Civil Engineers*

IN peace time the work of the Institution tends to become stereotyped in certain obvious directions determined by the development of its organisation through many years. With the routine of holding meetings for discussion, of examinations and elections, of setting up Committees for investigation and research, and of publishing the Journal, the essential functions of a body such as ours are apt to be obscured and overlaid by a species of ritual.

War, and the upheaval of our normal life which war brings to us, give us the incentive and the insistent need to hark back to the principles of our Charter, to examine our activities, and to bring them into line with the necessities that face us.

In many directions these activities must be curtailed by the exigencies of war conditions. For the present it will not be possible to hold regular meetings for the discussion of Papers. Certain time-honoured and traditional ceremonials, such as the Annual Dinner and the Conversazione, must be omitted, and the pre-occupation of so many members with their national duties, either military or civil, will reduce the volume of individual effort available for the direct prosecution of the objects of the Institution.

I believe the Institution's most important functions to be, firstly the maintenance of high standards, educational and practical, for the admission of new members, secondly the encouragement of members to contribute their experience and knowledge to the common stock of the profession, and thirdly the prosecution of research and investigation.

It would be lamentable if the essential means of equipping the rising generation with engineering knowledge and experience should be interrupted by military necessity. Not only is this younger generation of potential engineers a vital necessity for the military effort which has to be made and which may be of long duration, but it is even more a necessity for the period of reconstruction which will follow when peace is secured. At that time more than ever will Great Britain need a well-equipped body of trained engineers to secure its industrial recovery and to make good the inevitable wastage of its material resources. If the Institution can use its influence to secure this continuity in the process of "making new engineers" it will have succeeded in performing a service of great national value.

The second of the main functions of the Institution to which I have referred is the encouragement of members to contribute their experience and knowledge to the common stock of the profession.

Whatever may be the result of the present conflict in putting an end to the activities of those who have made aggression and terrorism the principal aim of national policy, I can see little hope within any measurable period of time of obtaining for the human race in any part of the world permanent immunity from attack from the air by evilly-disposed persons or organisations. The possibility of such attack must introduce into all our methods of design and construction of buildings and public works the additional strength and protective devices necessary to enable men to carry on their avocations in reasonable security. With the knowledge that has been gained already in the present experimental period, supplemented by that which will emerge from any

* Newcomen Society Presidential Address, November 8th, 1939, Abstracts.

† Trans., Newcomen Society, ix, 105–8, 134.

* Excerpts from the Presidential Address by Sir Clement D. M. Hindley, K.C.I.E.

ordeal through which we may have to pass, I see no inherent difficulty, either of design or of cost, in providing such reasonable protection for any organised community.

We shall look forward to publishing in the Journal whatever material may be made available in regard to this aspect of constructional work, so that our members may have the benefit of progress in the knowledge of the subject. We shall also endeavour to utilise the Journal for keeping members informed of progress in other branches of work and encouraging discussion.

I come now to the third main function, namely, that of research and investigation. In so far as it is possible for the various scientific organisations which have undertaken research for the Institution to continue their work, the Institution will maintain its financial support. Some of these researches have already had to be suspended owing to the exigencies of National Service, but others may be carried on to a conclusion. For the present it may not be possible to commence any new work of this kind, but whenever problems arise which seem suitable for investigation in the circumstances obtaining, we shall not hesitate to seek the necessary means of investigation. The Research Committee will remain in being, and will be called together when necessary to deal with problems which may be suggested to us. As in the past, we shall hold our resources in this respect available for any work which the Government may consider can best be carried out by our members.

As regards individual members, their fundamental duties are so obvious as hardly to need re-stating. As citizens they will cheerfully and resolutely obey any call that may come to them in the national interest. As engineers they will give their accumulated knowledge and experience to whatever efforts may be demanded of them, and in whatever sphere they may be called upon to serve. While concentrating all their specialised capacity on the furtherance of the national effort, they must keep always before them the work of reconstruction and advance in the standards of civilised life throughout the world that will have to be undertaken when the time comes for the human race to be freed from the recurring menace of gangster nationalism. If we had not that hope of an even larger and more spacious freedom than we have hitherto known, the outlook would be dark indeed. We may, however, be sure that when we have passed through the present ordeals and have achieved the victory for freedom for which we are now fighting, there will be unimagined opportunities for applying for the benefit of the human race those advances in science which are even now taking place under the stimulus of war. It is necessary for all engineers to continue to keep abreast of developments in engineering science and practice, and so to fit themselves for this great work of the future.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

GAS POWER FOR ROAD TRANSPORT

Sir,—It is rather amusing to read of the recognition of producer gas power for road vehicles by the Government, as if it were the product of recent scientific discovery; it is, of course, the fact that during the past few years small plants have been greatly improved by numerous workers in this field whom it might be invidious to mention by name, but it would also be fair to report that the writer had a very satisfactory demonstration on an Albion lorry fitted with a Smith and Parker gas producer as far back as *circa* 1921. In this apparatus the fuel was fed by revolving rollers to the top of the producer, the ash being removed by a similar pair of rollers at its lower end, and the supply (of anthracite fuel) was, in the example demonstrated, carried on the roof of the cab, whence it fed itself by gravity to the feed rolls; an arrangement that was not perhaps entirely satisfactory, since there is a distinct recollection of having to stop and shake the whole vehicle violently on its springs to restart a reduced feed.

To-day, with the combined hopper and producer in one chamber, and the discovery of the advantages of injecting raw water instead of generating steam, these troubles have departed, but it seems a little unjust to those who have laboured so long and so arduously in this field that when recognition arrives, their work is dismissed or forgotten, while some coup of salesmanship credits the modern exponents with a novel invention. "*Carpe diem*" is indeed a true motto to follow, and the way of the pioneer inventor is as hard as the proverbial way of the transgressor, but, of course, the gas producer principle had grown whiskers already, even at the date above mentioned, so far as stationary plant was concerned.

Now that it has taken a second war to readjust the National outlook on the value of indigenous fuels we may, I think, expect to see some remarkable developments in the revival of both gas and steam power in the immediate future, but with some 3000 gas-driven vehicles successfully at work on the Continent, to claim novelty for our belated recognition of the obvious is a little misleading.

S. P. Christie.

Southsea, November 9th.

Sixty Years Ago

Elementary Thermodynamics

Sixty years ago the word "entropy" had not found its way into our columns or the common parlance of engineers. The science of thermodynamics had, in fact, still, in very large measure, to be developed. There was, as a consequence, much confusion concerning thermal phenomena, and much doubt and even ignorance concerning the theory of the steam engine. Evidence to that effect is provided by the fact that towards the end of 1879 our correspondence columns were opened to a prolonged discussion on the theory of the compound engine, the correspondence having been initiated by a letter from a young student who courageously confessed that when given the task of designing such an engine he could find no guidance in any text book available to him. We assisted him by expounding the elements of the theory of the compound engine in a leading article. The student's letter and our article gave rise to the prolonged correspondence to which we have referred, a correspondence which, although entertaining in its way, would to-day be largely unprofitable to summarise. More interesting perhaps is an article in our issue of November 28th, 1879, the title of which "The Work in a Pound of Steam," is by itself further evidence of the fact that in those days engineers were less familiar with thermal phenomena than we are to-day. It would appear that one of the chief stumbling blocks to a proper understanding of the theory of steam engines was in those days the conception of latent heat. Obviously with an eye on the kinetic theory of gases we endeavoured to explain the nature of latent heat by comparing the molecules of steam with projectiles discharged from a rifled weapon. The linear motion of such a projectile, we said, represented latent heat, while its rotary motion represented sensible heat. We added that only the rotary motion of the projectile on its axis was immediately available for conversion into work, or in other words, latent heat must be converted into sensible heat before it became available. As a numerical illustration we assumed that we had one pound of steam at 100 pounds total pressure, the corresponding temperature being 328 deg. The total quantity of heat in the steam was 1,209,110 foot-pounds made up of 190,298 foot-pounds expended in raising the original ice from −461 deg. to 32 deg., 108,624 foot-pounds required to melt the ice at 32 deg., 228,512 foot-pounds for heating the water from 32 deg. to 328 deg., and 681,676 for converting the water into steam. Then followed the statement that of the total quantity of heat the only portion upon which we could draw was the sensible heat of 228,512 foot-pounds. It was, however, impossible to utilise all this sensible heat. If we expanded the steam ten times its final temperature would be 193 deg., and the difference between the initial and final temperatures would be 135. Multiplying that figure by 772 we got 104,220 foot-pounds as the greatest possible amount of work which could be obtained from the pound of steam by a perfect engine. . . . For the initial and final temperatures given in our article the Carnot cycle efficiency is 17·1 per cent. If the total heat in the steam is taken, as stated, at 1,209,110 foot-pounds, then the greatest amount of work which it is possible to recover from it in a perfect engine is 206,758 foot-pounds, or just about twice the figure which we gave in our article.

Obituary

SIR ANDREW SCOTT

Many among our readers, who are associated with shipbuilding and marine engineering, will regret to learn of the death at the age of 82, of Sir Andrew Scott, who for over thirty years was the Secretary of Lloyd's Register of Shipping. Sir Andrew died at his home at Summer Court, Shooter's Hill, London, S.E.18, on Friday, November 10th. He was the son of the late Mr. William Keir Scott of Glasgow, and was born in Glasgow on January 16th, 1857. At the early age of twelve he entered the Glasgow office of Lloyd's Register of Shipping, and after serving there for some years, was transferred to London in 1874. In 1884 he took a leading part in the compilation of the "Annals of Lloyd's Register," which was issued in connection with the Jubilee of the Society, and it is notable that he was also responsible for the edition of the same work which was published fifty years later on the occasion of the Centenary of the Society in 1934.

In 1887 he was appointed Clerk to the Classification Committee, and in 1891 he became Chief Clerk. In 1904 he succeeded the late Mr. Dryhurst as Secretary, and remained in that position until his retirement from active duty in June, 1935. He had then completed the remarkable record of nearly 66 years' service with the Society.

Sir Andrew's service with Lloyd's Register covered a period of tremendous expansion in the mercantile marine, not only of this country, but throughout the world, and of widespread advance in naval architecture and marine engineering. This is well exemplified in the fact that at the commencement of his career with the Society the most notable ships of the day were the famous tea clippers "Cutty Sark" and "Thermopylæ," whereas at the time of his retirement that outstanding vessel, the "Queen Mary," had been launched and was being fitted out.

Sir Andrew rendered signal service to Lloyd's Register, whose sphere of operation and usefulness grew apace during the period of his Secretaryship. The Committee of the Society appropriately recognised his long and valuable service when, upon completion of his sixtieth year with Lloyd's Register, it resolved to mark the occasion by requesting him to allow his portrait to be painted and hung in the Society's building. Further evidence of its esteem and respect was shown upon his retirement, when the Committee unanimously decided to elect him to be one of its number. In 1934—the year of the Society's Centenary—His Majesty The King was pleased to confer the honour of Knighthood upon Sir Andrew.

His loss will be keenly felt by a large circle of friends in the shipping industry, not only in this country, but throughout the world wherever the Society is known. His death will also bring a deep sense of personal loss to the members of the Society's Staff, in whose welfare he was always greatly concerned. He it was who inaugurated in 1882 Lloyd's Register Cricket Club, and the marked success which has attended the club and its annual dinners ever since was due in no small measure to his unfailing interest and support.

A memorial service will be held later in London, particulars of which will be announced in due course.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

HEXAGONAL-HEADED BOLTS (LOW-TENSILE STEEL); HEXAGONAL STEEL NUTS

Nos. 5 A.1. and A.16. A revised B.S. Specification for Low-tensile Steel Bolts (5 A.1), superseding B.S. Specification 4 A.1, and a new Specification for Hexagonal Steel Nuts (A.16) for aircraft purposes have been issued by the British Standards Institution. Since experiment has confirmed that it is permissible to use nuts of S.1 steel with high-tensile steel bolts (A.15), the hexagonal steel nuts, hitherto included in B.S. Specification 4 A.1, for Aircraft Bolts and Nuts (Low Tensile), have been re-issued as a separate specification (A.16) so as to be available for use with bolts of either type. In the revised specification 5 A.1 the material is limited to S.1 steel; the $\frac{1}{4}$in. and $\frac{5}{16}$in. diameter bolts have been eliminated; a chamfer of 15 deg., or alternatively a washer face, is required on the underside of the heads and the screw threads may be either cut or rolled subject to their passing approved gauges. In the new specification A.16 no alterations have been made to the dimensions of the nuts (ordinary, thin, slotted, and castle types), but S.80 steel is specified in place of S.61 steel when stainless properties are required. The price of each of these specifications is 1s. 2d. each, post free.

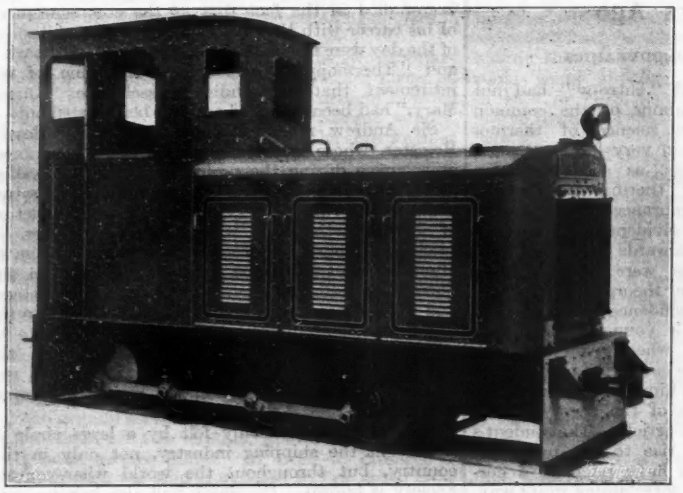
COMPARISONS OF HARDNESS NUMBERS

(B.S. No. 860).—With the increasing adoption of hardness testing there has arisen a need for a means of comparing the units of hardness of one system with those of another. At present the most widely employed methods of measuring hardness are the "Brinell," "Diamond Pyramid," and "Rockwell" tests. There are individual preferences for using these, but cases are increasing where the same material is tested in different works or laboratories by these three different methods. There has, in consequence, been a general demand for some means of correlating the most used A, B and C Scales of the Rockwell test with those of the Brinell and Diamond Pyramid tests. Investigations show that there can be no general theoretical relationships between these scales and empirical formulæ devised from experiments only hold closely for materials of approximately similar composition and in a given condition. Variations in the empirical relationships result if the conditions as regards composition, heat-treatment and cold work differ appreciably, and also if different loading ratios are selected in the Brinell test. On the other hand, groups of materials which are similar as regards composition, cold work, etc., may give fairly close comparisons. This new table of approximate comparisons of hardness numbers is issued merely to give an indication of the order of the relationship between the three systems of hardness readings, and must not be used as a standard for the conversion of hardness values given on one scale in any B.S. Specification to those of another scale. The Diamond Pyramid Scale has been taken as the basis of reference and the most probable comparative values adopted from published experimental results.

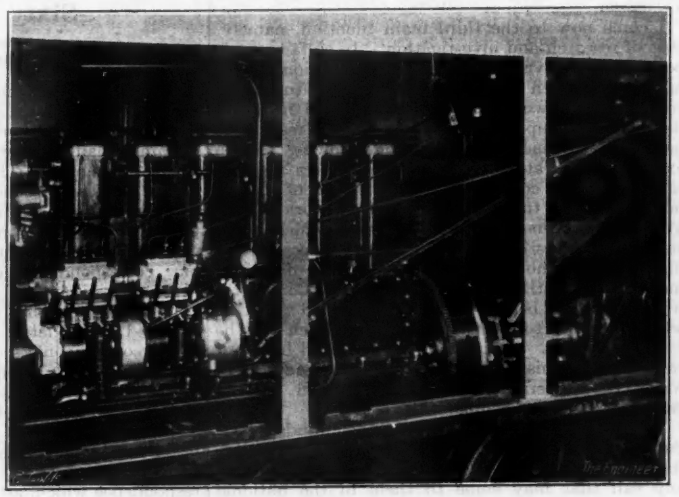
78 H.P. Narrow Gauge Locomotive

THE small locomotive illustrated was recently shipped to a South African mining company by The Hunslet Engine Company, Ltd., of Leeds. It is a very useful size for 2ft 6in. gauge work. The line on which this locomotive is to work involves a long gradient against the load, and it was imperative that a reasonably high speed should be maintained, whilst axle load was to be kept moderate. The locomotive has a factor of adhesion of 4·3 to 1. The power unit employed is the Gardner 6L2 oil engine, capable of developing 78 B.H.P. at 1300 r.p.m. Great care has been taken to protect all wearing parts from the dust present at the site, and very thorough filtering of fuel oil, lubricating oil, and the air supply has been arranged. The air filters have been so placed that the driver can clean and replace them in a few moments without taking off the engine-room side covers. The cooling water temperature is controlled by thermostats, the water being circulated by pump through a large sectional radiator having quickly detachable and interchangeable elements. The plate type friction clutch is of large size, self-cooling, and capable of transmitting over 100 per cent. overload. The three-speed gearbox has ratios selected by the mining company's engineers to suit their conditions. It follows the standard "Hunslet" practice, combining the change speed gearbox with the reverse gears and final drive jack-shaft. Whilst it is possible to split the gearbox on the various shaft lines, so that any shaft may be lifted straight out, yet the whole gearbox may be lowered out of the frame as a unit. The total weight of 8 tons 1 cwt. is a small figure for a 78 H.P. locomotive having a maximum tractive effort of 4190 lb., especially as it has not been achieved at the expense of even distribution. The maximum axle load is 2 ton 17 cwt. The following are particulars of the locomotive :—

Diameter of coupled wheels ...	2ft.
Wheelbase	5ft. 3in.
Length over buffer beams	13ft. 9½in.
Maximum speeds in gears	5·9, 11·5 and 18·7 m.p.h.
Maximum tractive effort	4190 lb.
Weight in working order	8 tons 1 cwt.
Maximum axle load	2 tons 17 cwt.
Factor of adhesion	4·3 to 1.



78 H.P. NARROW GAUGE LOCOMOTIVE



POWER UNIT OF NARROW GAUGE LOCOMOTIVE

Lightweight Marine Oil Engines

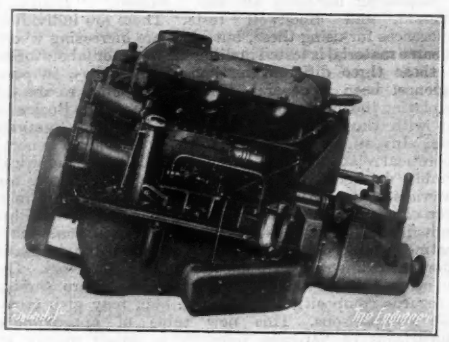
WE illustrate in the accompanying engraving a new arrangement of the P6 six-cylinder oil engine manufactured by F. Perkins, Ltd. Known as the P6M type, it is a six-cylinder engine designed for marine use, and represents a range of three engines especially suitable for the propulsion of high-speed craft. With a bore and stroke of 3½in. and 5in. respectively, the engine has an output of 65 B.H.P. at the maximum recommended cruising speed of 2000 r.p.m. Its maximum output at 2500 r.p.m. is equal to 80 B.H.P., and its weight is stated to be but 950 lb. It has therefore a high power to weight ratio, comparable, it is claimed, to that of petrol engines of equal power, and for this reason it can be used to advantage in high-speed boats.

The engine is also made as a four-cylinder unit, known as the P4M, having a cruising output of 43 B.H.P. at 2000 r.p.m., and a maximum of 53 B.H.P. at 2500 r.p.m., and a weight of 780 lb. A larger engine, the S6M type, completes the range ; it has a bore of 4⅜in. and the same stroke of 5in., with outputs of 100 B.H.P. and 130 B.H.P. at 2000 and 2500 r.p.m. respectively ; its weight is 1200 lb.

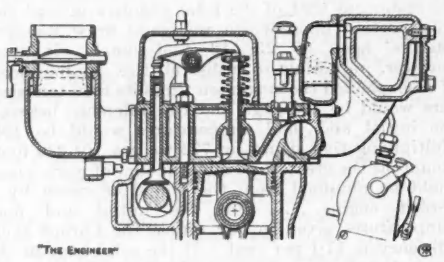
In most respects the large and small engines in the group are similar in design. Each is fitted with a reverse gear, and the weights quoted above include this component. The reverse gear is of the epicyclic type, incorporating a multi-plate clutch and spur gearing. The mechanism is enclosed and bolted directly to the engine sump and a rear extension on the cylinder block, lubrication being by pressure from the engine system. If required, a 2 to 1 internal tooth reduction gear, for use with the epicyclic gearbox, can be supplied, or, alternatively, a 2 to 1 or 3 to 1 single helical reduction gear can be used in conjunction with a bevel reverse gearbox.

The general design follows the firm's usual practice. The cylinder block and crankcase is a one-piece casting carrying the camshaft high up immediately under the head, in an oil bath. Seven bearings support the crankshaft on the six-cylinder engine. They are provided with steel shells lined with lead-bronze, and supported by rigid forged steel caps. The camshaft is carried in four bearings. An automatic tensioning device is incorporated in the chain drive to the camshaft and fuel pump shaft. Cylinder head and combustion chamber design utilises the firm's "Aeroflow" combustion system, probably familiar to our readers, as it has been described previously in these pages. Briefly, the system combines direct and indirect, or air cell, combustion chambers by utilising a two-hole injecting nozzle, the spray from one hole of which enters the open combustion chamber, the other directing its spray into an air cell. The arrangement is shown in the drawing reproduced herewith. The cylinder head is a one-piece chromium iron casting, carrying the tappets and rocker gear which operate two overhead valves per cylinder.

Accessories and auxiliaries include C.A.V.-Bosch fuel injection equipment, the fuel pump being fitted with a pneumatic governor, and a water-cooled exhaust manifold made in an alloy claimed to resist sea water corrosion. For driving a dynamo and water pump an enclosed auxiliary drive is arranged. The water pump is of the gear type, is positively driven, and is provided with plastic bearings stated to require no lubrication. Mounted at the rear of the engine is an oil cooler constructed of bronze.



80 B.H.P. MARINE OIL ENGINE



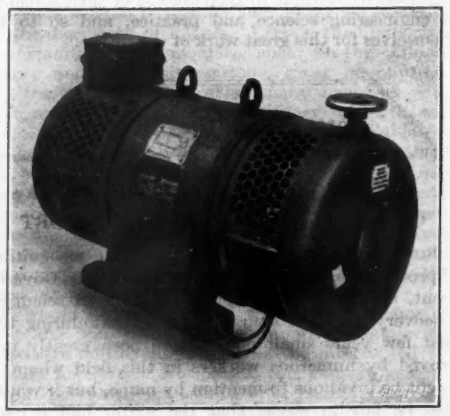
SECTION THROUGH CYLINDER HEAD

As may be seen in the illustration, the flywheel is mounted at the forward end of the crankshaft, this position having been chosen so that the engine can be mounted as low as possible in the boat. The maximum angle at which the engine can be installed in the boat is 15 deg., and at this angle full allowance has been made in the design for a further 3 deg. rise when the craft is under way. The engine is started by means of a 24-volt C.A.V.-Bosch axial starting motor engaging with a starter ring on the flywheel at the forward end of the engine. The dynamo is arranged to work at 12 volts, but is provided with a 24/12-volt change-over switch.

A Small A.C. Commutator Motor

OWING to the large and steady demand for Schrage type polyphase variable speed commutator motors of sizes in the region of 5 H.P., The British Thomson-Houston Company, Ltd., decided to develop the 4-pole machine as shown in the accompanying illustration. It has a maximum rating of 4 H.P., with a speed range not exceeding 2050/683 r.p.m. When rated at 3 H.P. any speed can be obtained between 2500 r.p.m. and zero. This machine should prove useful for small power drives such as those associated with conveyors, baking machinery, textile machinery, pumps, small printing presses, etc.

No auxiliary apparatus is needed other than a switch to connect it to the supply. The speed variation is obtained by merely turning the brushgear spindle. The motor weighs 265 lb. and measures 29⅝in. long, 13in. wide, and 15¼in. high. It is made in various ratings for three-phase, 50 cycle, 400–440–volt circuits.

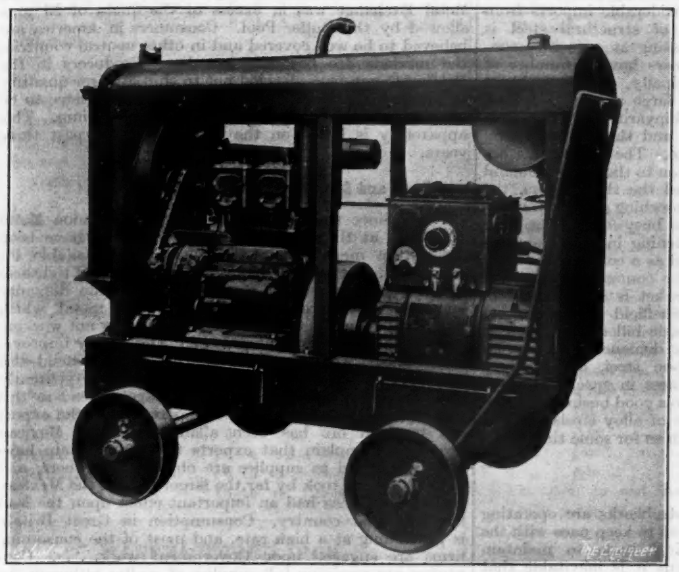


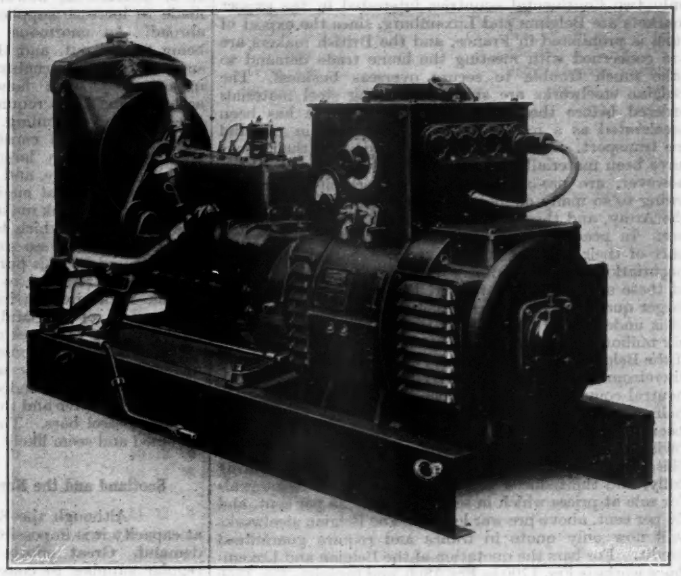
A.C. COMMUTATOR MOTOR

Engine-Driven Arc Welding Sets

THE accompanying illustrations show portable and semi-portable welding sets supplied by the Metropolitan-Vickers Electrical Company, Ltd., and fitted with the Metrovick "Paradyne" reverse-compound welding generator which dispenses with external reactors and resistances, and is claimed to have consistently good static and dynamic characteristics throughout all current ranges. Equipments are usually mounted on a substantial rigid channel-iron base frame, and, if required for use in exposed situations, are completely enclosed by a housing or canopy provided with easily removable sides that give

immediate and full access to all parts. Semi-portable sets without this housing usually have the fuel tank incorporated into the base and provided with a suction pump, the welding generator being set low down in the base, whereas sets with a canopy generally mount the fuel tank above the engine. The semi-portable equipment illustrated is a single-operator set capable of supplying 300 amperes for continuous hand-welding and is driven by a 24 H.P. 4-cylinder Ford petrol engine. The fuel tank is built into the base below the engine. Eye bolts are provided on the base frame for convenience of handling by crane or derrick. This set is approximately 70in. long by 44in. high by 25in. wide. The other set is of the portable type provided with draw-bar and driven by a 2-cylinder Russell-Newbery oil engine, with the fuel tank mounted above the generator. The generator is capable of supplying 200 amperes to a single operator. The set weighs 45 cwt. and is approximately 100in. long by 60in. high by 26in. wide. Double-operator "Paradyne" sets are frequently fitted and for special purposes even 8-operator sets have been supplied. Mounted on the top of each welding generator there is a standard "Paradyne" controller fitted with an ammeter and a plug and socket device for rapid selection of the most suitable current. These units are self-contained and require no external reactors. When necessary, auxiliary units such as air compressors, &c., can be mounted with the generator on the base frame and driven by the engine, and provision can be made for portable electric grinders, &c., to be driven from the generator.





PORTABLE AND SEMI-PORTABLE ARC WELDING GENERATOR SETS

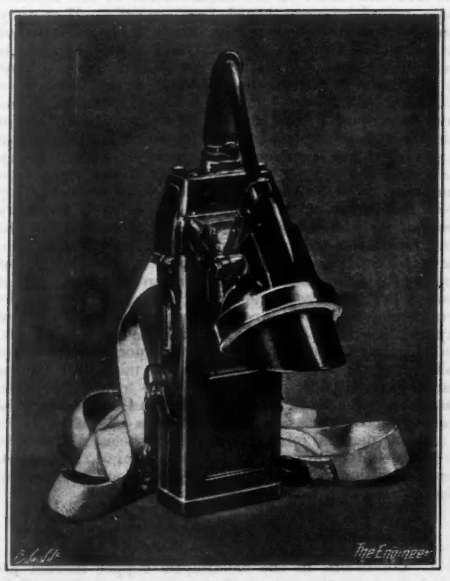
Portable Battery Lamps

In the accompanying illustrations are shown two particularly useful little battery lamps which have been designed by Ceag, Ltd., of Queen's Road, Barnsley, to comply with British Standard Specification A.R.P.3. Both the lamps are arranged for attaching to the person at chest height by means of light webbing harness which is rapidly and easily fastened by means of spring hooks. This method of carrying the lamp is particularly advantageous to A.R.P. and other workers, as it not only leaves the hands free, but lights the path a fair distance directly in front of the wearer. The lanterns have a bulb with two filaments, either of which can be brought into operation by turning a three-way switch. Should one filament fail, the second can be brought into immediate operation, and the necessity for replacing a bulb in the dark is avoided. These bulbs have a rated life of 600 hours continuous burning—300 hours on each filament.

The "Jellac" lamp illustrated above employs a 2-volt unspillable jelly acid battery having a low-consumption bulb. It provides a good light for fifteen hours' continuous use, and is claimed to have a life between nine and twelve months in continuous use before plate renewal is required. The battery is housed in a cast aluminium case, and the lantern itself is a thick bakelite moulding. The lamp is weatherproof and has a diffusing glass toughened to withstand mechanical shock. Its carefully designed cowl, in conjunction with the diffusing glass, directs light downwards and forwards to provide a distribution in compliance with the specification laid down.

"JELLAC" LAMP

The "Superlite" lamp shown below has an alkaline battery with tubular positive electrodes giving a burning capacity of eighteen hours in continuous use. The battery life is stated to be six years, and as in the case of the "Jellac" lamp, the only attention required is recharging and occasional topping up. Its case is of welded stainless steel, and it also has stainless steel contact springs and spray proof vents. The bulb and lantern used are similar to those of the "Jellac" lamp. The weight of these lamps, when their capacity is taken into account, is not particularly large, the "Jellac" in working order weighing 5 lb. 6 oz., and the "Superlite" 3 lb. 14 oz.

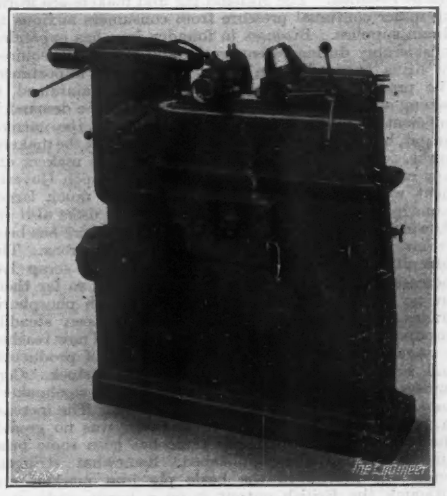


"SUPERLITE" LAMP

Re-Designed Capstan Lathe

The C.V.A. precision capstan lathe was introduced to the market by E. H. Jones (Machine Tools), Ltd., Edgware Road, The Hyde, London, N.W.9, about two years ago. Considerable development work has since taken place. The latest machine is illustrated herewith. The "H"-gear infinitely variable speed mechanism was previously mounted alongside the machine in the form of a separate unit with a flat belt drive from the "H"-gear pulley on to the lathe headstock. In the redesigned machine, however, it is completely built into the machine and connected to a flange motor by twin vee belts, the drive then being taken to the spindle by an endless flat belt. The infinitely variable speed range is 250–2500 r.p.m. The push-button control for the driving motor is conveniently situated at the front of the machine. The spindle, which is of nitralloy, has also been re-designed and is mounted in adjustable phosphor bronze bearings, which are provided with pressure lubrication from a new force feed pump in the headstock. An oil pressure gauge is provided at the front of the machine, and the pumps for pressure lubrication and also for the coolant are completely enclosed within the main casting, both being driven from the main drive motor. Easily removable filters are provided for the lubricating and coolant systems. Incorporated in the spindle is a new quick-action collet attachment with a capacity up to $\frac{5}{8}$in. and the turret has a working stroke of $4\frac{1}{2}$in. Operation of the five station turret is effected by a large star wheel through a rack and pinion, and when only two stations are being used there is a considerable saving of time, owing to the provision of a new reversing mechanism.

The question of casting design has received very close attention in the development of the machine, and as a result the designers and the foundry have produced a set of castings of high quality and with adequate internal ribbing, so that rigidity is assured.



PRECISION CAPSTAN LATHE

The new machine is very similar in its main dimensions to its predecessor, the height of centres being $3\frac{1}{2}$in., swing over bed $6\frac{3}{4}$in., swing over cut-off slide $3\frac{1}{4}$in., bar capacity $\frac{5}{8}$in., and length of bed 36in.

Old Rails for Steel Piles.—In the United States the Southern Pacific Company is using old rails for steel piles. The rails are welded together in groups of three with the heads in the centre. Welds 2ft. long are made at each end and at intervals along the length of the rails welds 6in. long are made. Piles up to 39ft. long made in this way are said to have proved particularly efficient in use.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The Continental Steel Trade

The Continental iron and steel industries are gradually adjusting themselves to war conditions. The only two Continental countries interested in the export markets are Belgium and Luxemburg, since the export of steel is prohibited in France, and the British makers are too concerned with meeting the home trade demand to take much trouble to secure overseas business. The Belgian steelworks are steadily shipping steel materials ordered before the war, and lately the rate has been accelerated as a result of the improvement in rail and sea transport. As a result the total orders on their books have been materially reduced. The Belgian steelmakers, however, are pre-occupied with the scarcity of labour owing to so many of their men having been called up for the Army, and there is also a shortage of coke, coal, and ore. In peace time the Belgian works draw the greater part of their supplies of coke and ore from France, and negotiations are proceeding with a view to the resumption of these shipments. Naturally, the French are requiring larger quantities of these raw materials for their own use. It is understood that Belgium is asking for the supply of six million tons of ore, but that this will only be supplied if the Belgians agree that no part of the steel manufactured therefrom will go to Germany either directly or through neutral countries. As a consequence all sales of steel are being carefully scrutinised by the Belgians. There have been difficulties in the supply of Swedish ores to Belgium owing to the action of the German contraband control in the Baltic. The Belgian steelworks are not operating fully, and the reduced production is released at intervals for sale at prices which in some cases are 25 per cent. and 50 per cent. above pre-war levels. The Belgian steelworks will now only quote in francs and require guaranteed credit. For bars the quotation of the Belgian and Luxemburg works is Frs. 1700 to Frs. 1800, and for joists Frs. 1650 to Frs. 1700. The lowest price for plates is about Frs. 2000 f.o.b., for thin sheets Frs. 2200. There is a good export demand, but the tendency is for works to accept only a proportion of the business offering, since not only are the Belgian home trade requirements on a heavy scale, but the Luxemburg makers are reluctant to commit themselves far ahead. The latter works obtain most of their coke from Germany, and the position with regard to future supplies is by no means clear. As a result of these factors sales for export have been rather spasmodic.

The Pig Iron Market

Busy conditions have ruled in the pig iron market for the past few weeks, and as a result the stocks which had accumulated in the hands of the producers earlier in the year have been rapidly reduced. There are good tonnages still available and it is possible for consumers to obtain reasonably prompt delivery of most descriptions of foundry iron. Some tightness prevails in the low phosphoric department, consequently a greater use is being made of hematite. On the North-East Coast the production of Cleveland foundry iron has not been resumed and consumers' requirements are met from stocks which, however, have been considerably depleted. The use of this iron is confined principally to local consumers who are also receiving good quantities of Midland foundry irons. As the foundry trades grow busier there is an increasing demand and lately there has been some speculation as to whether the production of Cleveland foundry will be resumed. The Midland pig iron makers are working under continual pressure from consumers anxious to obtain supplies. Business in foundry iron has expanded considerably during recent weeks and is largely required by firms engaged upon work of national importance. The production, therefore, which is well maintained, is passing at once into consumption. In fact, the demand is sufficiently strong to take care not only of the current output, but to make inroads into the reserves at the makers' works. Most of the Midland light castings makers are now engaged to a greater or lesser degree upon Government work, and are therefore in need of much larger tonnages than before the war. Lancashire users also are showing greater interest in the market, and there has been a run upon Derbyshire and Staffordshire irons. The difficulty of obtaining sufficient supplies of scrap has increased the demand for foundry iron, but so far there are no indications of a shortage of the high phosphoric grades. Business in hematite iron has been steadily improving since the outbreak of war, and has now reached a stage at which the demand is in excess of production and is being satisfied by deliveries from stock. Consumers of this class of iron, including the steelmakers, are showing anxiety to cover well forward. The increase in prices announced in the latest Order was no greater than had been expected and there has been some brisk buying since it was published. Somewhat stringent conditions prevail in the basic pig iron market, and although the British output is on a heavy scale, it is anticipated that important purchases will be made abroad. If this is necessary it will be done through the British Iron and Steel Corporation.

The North-East Coast and Yorkshire

The situation of the steel industry on the North-East Coast has not been changed in any way by the increase in prices. The works have sufficient orders in hand to keep them busy until well into 1940, and whilst there is a considerable tonnage of business offering, negotiations in regard to it are more concerned with deliveries than any other question. The requirements of the principal consuming trades are growing, and whilst the steelworks are making great efforts to maintain deliveries, the time required for the execution of orders is slowly lengthening. A large proportion of the work is for the priority classes of consumers, and the needs of users of steel for ordinary commercial purposes are necessarily pushed into the background. A heavy tonnage of semi-finished steel is going into use, but outputs are insufficient to meet the greatly enlarged demand from the re-rollers. It is understood, however, that arrangements will be made to increase supplies by considerable imports from abroad. An enormous tonnage of structural steel is being turned out, and this is passing at once into consumption. The structural engineers have a number of important jobs in hand, principally on Government account, and their requirements, large as they are, look like steadily expanding. The shipyards also are busy upon all classes of construction, and their consumption amounts to a very large tonnage. The plate mills are working to capacity, and in addition to the heavy demand from the structural engineers and the shipbuilders, the locomotive and tank makers are absorbing good quantities. The sheet mills, which have been busy for months upon A.R.P. work, can see some slackening in the quantities now required for this purpose, and as a consequence have rather more tonnage to spare for commercial business. In the Yorkshire district the market is as active as in other parts of England. The Sheffield steelworks are producing big tonnages of soft basic billets, and even so are unable to keep abreast of the demand. There is an increasing request for acid carbon steel, and delivery dates are being extended. Business in special steels is particularly active and there is also a good business passing in bright steel bars. The makers of alloy steels are well occupied and seem likely to remain so for some time.

Scotland and the North

Although the Scottish steelworks are operating at capacity it is impossible for them to keep pace with the demand. Great efforts are being made to maintain regular supplies to consumers, but it is inevitable that they should suffer some disappointment, and the time required for the execution of orders is gradually lengthening. The demand for structural steel is phenomenal, and in spite of the huge tonnages which are being turned out consumers continue to agitate for supplies. The structural engineering firms in Scotland are providing an outlet for very heavy tonnages, and as most of them are engaged upon Government work a large proportion of the output comes within the priority categories. Most of these consumers are engaged upon important jobs and the demand from this quarter is likely to be maintained for a long time. Heavy tonnages are passing to the shipyards on the Clyde, and as all the yards are busily employed, their requirements are certain to be maintained if not increased during the coming months. The production of semi-finished steel is being pressed to the utmost, but still falls short of the requirements of the market. Some complaints are heard from re-rollers that they cannot maintain full operations owing to the difficulty of obtaining full supplies of billets and sheet bars. It is understood, however, that this will shortly be overcome by purchases from abroad. Although reports have been circulated that heavy purchases of semi-finished steel have been made in the United States, no transactions of this description have yet been completed. The production of small bars, sections, and strip, however, is on a heavy scale and the output is passing immediately into consumption. The Scottish marine engineers are taking up good quantities of steel and there has been a heavy demand for plates from the locomotive makers and the tank and boiler manufacturers as well as from the shipyards. The sheet mills continue to be well employed, but apparently some of the works are approaching the end of their A.R.P. contracts and are now in a position to take commercial business. An encouraging sign is that new export prices for sheets were issued at the end of last week, and this may indicate that after many months an attempt will be made to regain the export markets. In the Lancashire district extremely active conditions rule. Engineering firms are fully employed and are pressing the makers for deliveries of large tonnages of steel. There is a strong demand for high carbon and special alloy steels. Bright steel bars are also an active section of the market. Busy conditions rule at the forges and good tonnages of blooms are being taken up.

Copper and Tin

Conditions in the electrolytic copper market are satisfactory to the extent that consumers appear to be obtaining their requirements at the Control prices. No arrangement has yet been reached between the Ministry of Supply and metal merchants by which the latter can obtain remuneration for their services. At present they have to buy and sell copper at the same price and so suffer loss on running their businesses. Some consumers appear to have experienced a shortage of best selected copper, but most descriptions are readily available. Buying in the American market has slackened and it is probable that the raising of the arms embargo by the American Government has contributed to this feature. Since American vessels are not permitted to carry copper to England and France, neutral countries will have to fetch the metal in their own ships and, as this might present difficulties, it would have a tendency to check the demand and the rise in price. On the other hand, some big transactions have been entered into by the American producers, including the sale to France of 15,000 tons of American, African, and Chilian copper for delivery in six months. The American quotation remains firm at 12.50c. f.a.s. New York. At the same time domestic buyers are showing less interest in the market, although the quotation remains at 12.50c. d/d and some sales have been made at 12.75c. American producers are opposing the suggestion to reduce the present import duty of 4c. per lb. on copper to 2c. per lb. The intention is apparently to assist the import of Chilian copper, but it is pointed out that if the reduction is made it would also have to apply to Canadian copper. . . . The tin market appears to be getting more normal, and it is thought that the increase in supplies will have the effect of bringing the world prices back to a more reasonable level. On one occasion the day's turnover on the London Metal Exchange was in excess of the quota of 25 tons allowed by the Buffer Pool. Consumers in America are believed to be well covered and in other neutral countries the markets are becoming steadier. Producers in the Belgian Congo have decided not to ship a larger quantity of tin than the British Contraband Control believe to be necessary for the domestic consumption in Belgium. This apparently is based on the average for the past three years.

Lead and Spelter

Since the positions open on the London Metal Exchange at the commencement of the war have been cleared up more prompt lead has been available for consumers. At no time has there been any real tightness in the lead market, but occasionally a certain difficulty has been experienced in obtaining prompt metal, which may have been due to the Control machinery not working so smoothly as it does at present. The steady improvement in the working of the Control system should also result in more regular arrivals of Empire lead. Apparently there is little likelihood of any shortage of lead in this country, and from Mexico it is reported that the export tax on lead ore has been abandoned. The Mexican producers complain that exports to Great Britain have been suspended as supplies are obtained elsewhere, and as this country took by far the larger part of the Mexican production it has had an important effect upon the lead trade in that country. Consumption in Great Britain is proceeding at a high rate, and most of the consuming firms are engaged upon Government work. . . . Consumers are receiving full supplies of spelter although the bulk of this trade is being done through the Control. The brassmakers continue to take good quantities and there has been no relaxation yet in the demand from the galvanisers, although it is said that some of the sheet makers are reaching the end of their contracts for A.R.P. purposes. Some complaint has been heard of the difficulty which manufacturers experience in obtaining spelter for ordinary commercial purposes, but on the whole it is recognised that the demand from firms engaged on work of national importance must come first. It is generally believed that the stocks of spelter in this country at the beginning of the war were considerably larger than those of other non-ferrous metals, and as a consequence the position so far as supplies are concerned is entirely satisfactory. In the United States the rush to buy spelter which raised the price so rapidly has passed. There is, however, still a good demand, and as the American galvanisers are reported to be working at 78 per cent. of capacity that industry is likely to continue to provide a useful outlet for spelter for some time.

Steel Sheet Export Prices

Considerable interest has been aroused in the sheet trade by the announcement of revised export prices. For many months the sheet works have been concentrating upon the production of sheets for A.R.P. and it has been exceedingly difficult to obtain any material for export or, indeed, for the home trade apart from Government requirements. The announcement is taken by the market to indicate that the pressure of Government work has relaxed sufficiently to enable export business to be resumed, at any rate on a small scale in the not distant future. The new prices raise the quotation for 24-G galvanised corrugated sheets to £18 2s. 6d. f.o.b., and for black sheets to £15 12s. 6d. f.o.b. These are fixed prices for British Empire markets and mandated territories, but for other overseas markets apart from the Irish Free State they may be regarded as minimum quotations. The basis quotation for the Irish Free State for galvanised sheets is £18 12s. 6d. f.o.q., and for black sheets £16 2s. 6d. f.o.q.

CATALOGUES

HOPKINSONS, Ltd., Huddersfield.—Descriptive brochure of "Nolos," "Robut," and "Radus" steam traps.

JAMES BERESFORD AND SON, Ltd., Cato Street Works, Birmingham, 7.—A folder illustrating trailer fire pumps.

HOWARD CLAYTON-WRIGHT, Ltd., Tiddington Road, Stratford-on-Avon.—Leaflet on the "Clayflex" flexible pipe union.

HERBERT MORRIS, Ltd., Loughborough.—Illustrated list of chain slings, giving particulars of their construction, capacities, and uses.

GERM LUBRICANTS, Ltd., City Gate House, Finsbury Square, London, E.C.2.—A booklet entitled "'Germ' oils for Industrial Plants and Machinery."

DALO, Ltd., 47, Victoria Street, London, S.W.1.—A leaflet on the firm's system of treating lights in buildings in order to comply with the "black-out" restrictions.

SAFEGLASS (SPECTRUM, Ltd.), 34, Tenterden Drive, London, N.W.4.—A leaflet introducing "Safeglass," a solution for applying to glass in order to prevent it splintering.

SHEPPARD AND SONS, Ltd., Bridgend, Glam.—Illustrated booklet of some of the firm's products which include coal breakers and washers, elevators and conveyors, structural steelwork, pit cages, etc.

PHILIPS LAMPS, Ltd., Century House, Shaftesbury Avenue London, W.C.2.—Data sheets describing the use of "Philora" electric discharge lamps for lighting industrial and commercial premises under war conditions.

RADIATION, Ltd., 164–172, Queen Victoria Street, London, E.C.4.—Particulars of the "Eagle" coke heater for industrial and other buildings, made by John Wright and Co., Ltd. These heaters burn coke and are for capacities from 5000 to 15,000 cubic feet.

Current Prices for Metals and Fuels

Official maximum home trade prices, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are nominal for Empire Markets.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/–. (*D/d Teeside Area.*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	6 4 6	—
„ No. 1	6 4 6	5 15 6
Cleveland—		
No. 1	5 10 6	5 1 6
No. 3 G.M.B.	5 8 0	5 0 0
No. 4 Foundry	5 7 0	—
Basic	5 1 6	—
Midlands—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 10 0	—
„ „ Forge	5 7 0 to £5 9 0	—
Basic	5 1 6	—
Northampton—		
Foundry No. 3	5 7 6	—
Forge	5 4 6 to £5 6 6	—
Derbyshire—		
No. 3 Foundry	5 10 0	—
Forge	5 7 0 to £5 9 0	—
Scotland—		
Hematite, f.o.t. furnaces	6 4 6	—
No. 1 Foundry, ditto	5 12 0	—
No. 3 Foundry, ditto	5 9 6	—
Basic, d/d	5 1 6	—
N.W. Coast— Hematite Mixed Nos.	6 4 6 d/d Glasgow 6 10 0 „ Sheffield 6 16 0 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs. and Yorks—		
Crown Bars	12 15 0	—
Best Bars	13 0 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	11 5 6	—
No. 4 Quality	11 15 0	—
Scotland—		
Crown Bars	12 15 0	12 5 0
Best	13 0 0	12 15 0
N.E. Coast—		
Crown Bars	12 15 0	12 5 0
Best Bars	13 0 0	12 15 0
Double Best Bars	13 15 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	13 7 6	—

STEEL.

	*Home. £ s. d.	†Export. £ s. d.
London and the South—		
Angles	11 10 6	10 0 0
Tees	12 10 6	11 0 0
Joists	11 10 6	10 0 0
Channels	11 15 6	10 5 0
Rounds, 3in. and up	12 10 6	11 0 0
„ under 3in.	13 1 6‡	11 0 0
Flats, under 5in.	13 1 6‡	11 0 0
Plates, ¾in. (basis)	11 15 6	10 2 6
„ 7/16in.	12 0 6	10 7 6
„ ½in.	12 5 6	10 12 6
„ 7/16in.	12 10 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 13 0	11 12 6
North-East Coast—	£ s. d.	£ s. d.
Angles	11 8 0	10 0 0
Tees	12 8 0	11 0 0
Joists	11 8 0	10 0 0
Channels	11 13 0	10 5 0
Rounds, 3in. and up	12 8 0	11 0 0
„ under 3in.	12 19 0‡	11 0 0
Plates, ¾in. (basis)	11 10 6	10 2 6
„ 7/16in.	11 15 6	10 7 6
„ ½in.	12 0 6	10 12 6
„ 7/16in.	12 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 8 0	11 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	11 8 0	10 0 0
Tees	12 8 0	11 0 0
Joists	11 8 0	10 0 0
Channels	12 13 0	10 5 0
Rounds, 3in. and up	12 8 0	11 0 0
„ under 3in.	12 19 0‡	11 0 0
Flats, 5in. and under	12 19 0‡	11 0 0
Plates, ¾in. (basis)	11 13 0	10 2 6
„ 7/16in.	11 18 0	10 7 6
„ ½in.	12 3 0	10 12 6
„ 7/16in.	12 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 10 6	11 12 6

STEEL (*continued*).

	*Home. £ s. d.	†Export. £ s. d.
Glasgow and District—		
Angles	11 8 0	10 0 0
Tees	12 8 0	11 0 0
Joists	11 8 0	10 0 0
Channels	11 13 0	10 5 0
Rounds, 3in. and up	12 8 0	11 0 0
„ under 3in.	12 19 0‡	11 0 0
Flats, 5in. and under	12 19 0‡	11 0 0
Plates, ¾in. (basis)	11 10 6	10 2 6
„ 7/16in.	11 15 6	10 7 6
„ ½in.	12 0 6	10 12 6
„ 7/16in.	12 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 8 0	11 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	11 8 0	10 0 0
Tees	12 8 0	11 0 0
Joists	11 8 0	10 0 0
Channels	11 13 0	10 5 0
Rounds, 3in. and up	12 8 0	11 0 0
„ under 3in.	12 19 0‡	11 0 0
Flats, 5in. and under	12 19 0‡	11 0 0
Plates, ¾in. (basis)	11 13 0	10 2 6
„ 7/16in.	11 18 0	10 7 6
„ ½in.	12 3 0	10 12 6
„ 7/16in.	12 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6

Ireland—f.o.q.—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	11 8 0	11 10 6
Tees	12 8 0	12 10 6
Joists	11 8 0	11 10 6
Channels	11 13 0	11 15 6
Rounds, 3in. and up	12 8 0	12 10 6
„ under 3in.	12 19 0‡	13 1 6
Plates, ¾in. (basis)	11 10 6	11 13 0
„ 7/16in.	11 15 6	11 18 0
„ ½in.	12 0 6	12 3 0
„ 7/16in.	12 5 6	12 8 0
Un. 7/16in. to ¼in. incl.	12 12 6	12 15 0

‡ *Rounds and Flats tested quality ; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.		Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	15 2 6	11-G. to 14-G.	14 0 0
13-G., d/d	15 10 6	15-G. to 16-G.	14 10 0
14-G. to 20-G., d/d	15 17 6	17-G. to 18-G.	14 15 0
21-G. to 24-G., d/d	16 2 6	19-G. to 20-G.	15 0 0
25-G. and 26-G., d/d	16 17 6	21-G. to 24-G.	15 12 6

Irish Free State, minimum £16 2s. 6d., f.o.q., 24-G. basis.

The home trade sheet prices are for 4-ton lots and over ; 2-ton to 4-ton lots, 7s. 6d. per ton extra ; and under 2-ton lots to 10-cwt., £2 2s. 6d. per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	18 12 6
2-ton to 4-ton lots	19 0 0
Under 2 tons to 10 cwt.	20 12 6

Export : General, £18 2s. 6d., f.o.b., 24-G. basis.
Irish Free State, minimum £18 12s. 6d. f.o.q.

Tin-plates—
20 by 14 basis, f.o.t., Bristol Channel Ports, 21s. 6d.
Tin-plate Bars, d/d Welsh Works, £8 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra ; less than 35 tons, 10s. extra.

	£ s. d.
Soft, untested	8 7 6
„ (up to 0·25% C.), tested	8 12 6
Basic (0·33% to 0·41% C.)	8 17 6
„ Medium (0·42% to 0·60% C.)	9 10 0
„ Hard (0·61% to 0·85% C.)	10 0 0
„ „ (0·88% to 0·99% C.)	10 10 0
„ „ (over 0·99% C.)	11 0 0
Rails, Heavy, 500-ton lots, f.o.t.	10 3 0
„ Light, f.o.t., up to and including 25 lb. per yard	12 2 6

FERRO ALLOYS.

	Per Ton. £ s. d.	
Tungsten Metal Powder	4/5½ per lb.	
Ferro-Tungsten	4/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£36 0 0	(nominal)
„ „ 6 p.c. to 8 p.c.	£33 0 0	(nominal)
„ „ 8 p.c. to 10 p.c.	£33 0 0	(nominal)
„ „ Max. 2 p.c. carbon		(nominal)
„ „ „ 1 p.c. carbon		(nominal)
„ „ „ 0·5 p.c. carbon		no quotation
„ „ „ carbon-free	1/2d. per lb.	
Metallic Chromium	2/7½ per lb.	
Ferro Manganese (loose), 76 p.c.	£18 to £19	home
„ Silicon, 45 p.c. to 50 p.c.	£16 10 0	
„ „ 75 p.c.	£26 0 0	
„ Vanadium	14/– per lb.	
„ Molybdenum	5/6 to 5/7½ per lb.	
„ Titanium (carbon-free)	£87 10s. per ton	
Nickel (per ton)	£190 to £195 per ton	
Cobalt	8/– to 10/– per lb.	

NON-FERROUS METALS.

(*Official Prices, November 15th.*)

	Home.
Copper—	
Electrolytic	£51 c.i.f. U.K. ports
Billets	£55 „
Cakes	£51 12 6 „
Cathodes	£50 10 „
Wire rods	£55 d/d buyers' premises
Sheets, Hot rolled	£85 0 0
	Home.
Tubes, Solid Drawn (basis)	13½d.
„ Brazed (basis)	13½d.
Brass—	
Ingots, 70/30, d/d Birmingham	£43 to £44
	Home.
Tubes, Solid Drawn 2/1 Alloy	12½d.
„ Brazed	14½d.
Tin—	
Cash	£230 0 0
Three Months	£230 0 0
Spelter—	
G.O.B. Foreign	£15 ex ship, (duty for buyers' account).
Empire zinc	£17 5 ex ship, London.
Lead—	
Pig lead, foreign	£16 12 6 ex ship (duty for buyers' account).
Empire lead	£17 ex ship.
Aluminium Ingots (British)	£94 (net)

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	21/6 to 22/–
Hamilton Ell	22/–
Splints	23/–
Ayrshire—	
(f.o.b. Ports)—	
Steam	20/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	21/–
Unscreened Navigation	21/6 to 22/–
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	21/–
Secondary Steam	20/3

ENGLAND

South, Yorkshire, Doncaster—	
Steam Hards	19/– to 20/–
Washed Smalls	16/– to 17/–
Northumberland, Newcastle—	
Blyth Best	22/–
„ Second	21/–
„ Best Small	18/6
Unscreened	20/– to 21/–
Durham—	
Best Gas	22/6
Foundry Coke	29/3 to 30/–

SOUTH WALES

Cardiff—	
Steam Coals :	
Best Admiralty Large	25/– to 26/6
Best Seconds	24/6 to 26/–
Best Dry Large	24/– to 25/6
Ordinaries	24/– to 26/–
Bunker Smalls	18/6 to 21/–
Cargo Smalls	17/– to 18/–
Dry Nuts	30/– to 31/6
Foundry Coke	45/– to 60/
Furnace Coke	39/– to 40/–
Patent Fuel	27/6
Swansea—	
Anthracite Coals :	
Best Large	33/– to 36/–
Machine-made Cobbles	35/– to 43/–
Nuts	40/– to 45/–
Beans	33/– to 42/6
Peas	28/6 to 32/6
Rubbly Culm	16/– to 18/–
Steam Coals :	
Large Ordinary	22/– to 25/–

FUEL OIL.

Inland consumption : supplies in bulk : exclusive of Government tax of 1d. per gallon (other than for use in Diesel-engined road vehicles).

Ex River Thames Installation—	Per Gallon.
Pool Fuel Oil	4½d.
Pool Diesel Oil	5d.

All supplies are now controlled by the Petroleum Board and all prices are on a day to day basis and subject to alteration without notice.

After a short interval we again print to-day our Current Prices in their usual form. Maximum prices are now fixed and as there would be little point in reprinting the same page week after week we propose to give it only at intervals as and when important changes occur. As usual loose sheets will be sent to subscribers who notify us of their wish to have them. We may add that market changes are mentioned weekly in our Market Notes.

French Engineering Notes

(From our own Correspondent in Paris)

Scientific Research Engineers

A THREATENED shortage of engineers for the work of the National Centre of Applied Scientific Research has obliged the Government to give orders to all State departments directly interested in the problem of national defence to select a number of young engineers for a minimum of four years' complementary training in research laboratories. In a preamble to the order it is stated that engineers trained in State schools for work in the different departments enter upon those services as soon as they obtain their degrees, so that they have no opportunity of continuing scientific studies. Each of the thirteen State departments having problems of their own affecting national defence will transfer a number of engineers to research laboratories. There will be 62 of them in all, and during the new period of training they will retain the advantages of their situation as State engineers. The National Centre of Applied Scientific Research was instituted earlier in the year with the object of bringing State laboratories under one co-ordinating body, which centralises all problems of national defence and makes sure that each problem is dealt with by specialised experts in laboratories best equipped for the purpose. Recourse is had to private research workers and laboratories when necessary. Applied scientific research played a great part in the last war and had an immediate effect on industrial progress afterwards, when the State extended and developed specialised laboratories, and the famous Belleville establishment was created by Monsieur Breton, while a considerable number of private laboratories was installed. This private enterprise vegetated through lack of funds to provide laboratories with proper equipments. The value of scientific research work was now fully recognised, and a national subscription was raised to provide private laboratories with instruments that were badly needed. The threat of another war compelled the Government to carry out its plan of co-ordination for dealing with problems of national defence under the direction of a committee composed of leading scientists and research workers. It was clearly evident that another war would draw heavily upon the resources of scientifically trained engineers. So heavy has it become that the National Centre has had to arrange for an assured supply of reliable workers in the future, and the Government advises that vacancies in the State departments resulting from the transfer of engineers to laboratories, should be filled by outside engineers possessing a Bachelor of Science degree.

Science and Industry

It can hardly be supposed that the practical value now attached to the higher degrees will be in any way diminished after the war. Past experience, and the growing recognition of the importance to industry of applied scientific research, suggest the opening up of a wider field for the activities of engineers trained in research work. How far this will be done depends upon organisation. In France there is nothing like the same organisation as exists in Britain, although the necessity for it was recognised when the industrial slump showed that new methods would have to be employed to put industry on a sound and progressive basis, and in 1935 preliminary arrangements were begun for the creation of a National Centre of Scientific Research, which would do for industrial progress what the organisation, bearing a similar name, is now accomplishing for national defence. The movement was further accelerated by the recommendations of the Committee of Inquiry into National Production towards the end of 1937 that science should be regarded as an indispensible means of helping industry out of an apparently chaotic depression. Science is a term used in its widest sense to cover organisation and production methods, but research work is regarded as equally important in giving a more profitable trend to some existing industries and creating new ones. There are industrial problems of national interest still awaiting solution. The National Centre of Scientific Research that was initiated four years ago has just been given an official existence and is attached to the Ministry of National Education. The National Centre of Applied Scientific Research is controlled by the Ministry of National Defence. The latter has one specific object in view, while the newly-formed National Centre covers the whole range of scientific research, and is a State autonomous body which will assist in the creation of laboratories, subsidise missions, aid scientists to carry on their work, and do everything else that may be necessary to develop scientific inquiry in the national interest. This organisation may be expected to do much after the war to assist industry in adapting itself successfully to new conditions of international trade.

Railway Coaches

The Minister of Public Works, Monsieur de Monzie, stated at the end of September that the National Railway Company was preparing to carry out changes in the making up of trains by suppressing one of the three classes and providing a higher level of convenience and comfort in the two others. It is now affirmed that this change will begin on the 1st of December. Especially during the war, when rolling stock is primarily at the disposal of the military authorities and fewer trains are run for public service and carry heavier loads, it is undesirable, for reasons of economy and in the public interest, to run first-class coaches which are rarely used by paying passengers except on international trains. All parliamentary and suburban trains will be made up of second- and third-class coaches, of which there will be a larger number on each train. First-class coaches will be retained on long-distance express trains where they are needed, probably two a day on each of the main lines, but apart from these exceptions a special class will be constituted by coaches offering comfort in travelling by day and night, while sleeping accommodation will be provided in second- and third-class coaches on long distance expresses. The problem is somewhat complicated by the fact that while a relative uniformity of rolling stock fittings is possible for traffic within the frontiers, there can be no sacrifice of convenience in respect of international trains.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

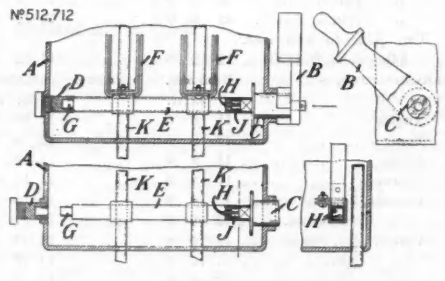
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR

512,712. February 17th, 1938.—QUICK MAKE AND BREAK ELECTRIC SWITCHES, Dorman and Smith, Limited, of Ordsal Electrical Works, Salford, and Thomas Smalley, of the same address.

This invention has reference to quick make and break electric switches and relates to the kind in which the movable contact arms are mounted on a detachable rotatable bar which is turned to open and close the circuit by a quick make and break mechanism. The invention provides an improved mounting of the bar in a switch of the kind referred to and according to this invention a single bar carrying the movable contact arms of the switch has at one end a circular bearing piece adapted to be housed in a retractable bearing member and at the other end has an aligning and coupling device co-operating with its counterpart on the quick make and break, whereby the bar can be rotatably aligned with, and connected to the quick make and break for operating thereby, or can be released therefrom for removal from the switch. As shown in the drawings the box A which is normally used mounted on a wall, or in an upright position is provided on one side with a lever B having a boss C, and opposite to this is a hollow screw D. The quick make and break boss normally also carries or forms part of the bar carrying the movable contact arms, but in the present instance the part of the bar E carrying the contact



arms F is detachable from the quick make and break mechanism which operates it. This arrangement is effected by forming one end of the part of the bar E with a bearing portion G which is received in the hollow screw D which can be moved in or out from the side of the box A by screwing it in the screwed opening in the box side. The part of the bar E at the opposite end has two holes H, which align with two pins I projecting from the other part of the bar in the form of a short extension piece on the boss C, or any other suitable aligning and coupling device which will ensure that the detachable part of the bar E will be rotated with the boss C. When the detachable part of the bar E has been fitted to the boss C and the other end has been aligned with the screw D the latter is screwed up to press the bar tightly against the boss C, but not so tightly as to cause it to bind in the screw. When it is desired to fix or remove a lead K which passes under the detachable part of the bar E the screw D is turned outwardly to allow the bar to be moved axially till its other end is free of the pins J, on the short extension piece of the bar on the boss, and as soon as this end is clear the detachable bar and with it the contact arms F can be lifted clear to expose the bottom of the box and leave the leads clear for manipulation. In a similar manner the detachable bar can be quickly reinserted in place.—*September 25th*, 1939.

METALLURGY

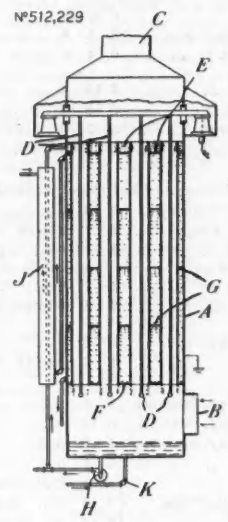
512,603. January 13th, 1939.—AMALGAMATION OF METALS Allgemeine Treuhand A.G., Zürich, Switzerland.

For many purposes amalgamated metals are used, partly in order to give the metal which is mixed with mercury protection against too strong attack by acids and lyes, partly in order to influence the physical properties of the metals. If the mercury is only brought mechanically into contact with the metal to be amalgamated, *e.g.* by rubbing a metal plate in presence of mercury, then the amalgamation is non-uniform and little adhesive. According to the invention good and intimate amalgamation both in superficial and deep action has been obtained by cleaning and electrolytically deoxidising the metal by making it the cathode in an electrolytic bath and bringing it subsequently immediately into contact with mercury. If the application of the mercury to the cleaned and deoxidised metal is effected immediately after deoxidation there occurs a specially intimate union of the mercury and the metal.—*September 20th*, 1939.

MISCELLANEOUS

512,229. February 2nd, 1939.—CONDITIONING OF GASES, PARTICULARLY AIR, *Research Corporation of New York, 405, Lexington Avenue, New York City, United States of America.* Lodge-Cottrell, Ltd., George Street (Parade), Birmingham.

A principal purpose of of this invention is the provision of a method and means by which the temperature and humidity of air can be adjusted and suspended material can be removed therefrom. In the embodiment shown a casing A is provided with inlet B and outlet C for the air or other gas to be treated, and having a sump at the bottom. The apparatus is provided with attenuated discharge electrode members D, supported from bars and connected to a source of high tension current (not shown). The casings are connected to a terminal of the high tension current source either directly or by grounding. Each of the electrodes is in a cylindrical member forming a conduit for the flow of gas along the discharge electrode and providing a complementary extended surface electrode for the collection of particles precipitated out of the gas by the action of the electric field between the attenuated electrode and the extended surface electrode. A header below the upper ends of members forms reservoir E surrounding the upper ends of the conduits. A sheet F joins the lower ends of the members with the casing and the space between the sheet and header is divided by horizontal partitions G alternately ending short of one side and the other of the casing to provide a tortuous path for the flow of fluid through the space surrounding the conduits. In the operation of the apparatus, a stream of air is caused to flow upwardly through conduits. A deliquescent liquid, such as a solution of calcium chloride, is circulated by means of pump H from the sump to reservoirs E, whence it overflows over the inner surfaces of conduits and into the air stream flowing up. A cooling fluid, for example, water from a cooling tower, is passed into heat exchanger J where it preliminarily cools the hygroscopic liquid to a predetermined temperature and then passes through the space between conduits where it serves to maintain the liquid flowing down the inner surfaces of the conduits at the predetermined temperature by carrying away the latent and specific heat absorbed by the liquid from the air. The concentration of the liquid is maintained substantially constant by pumping a portion to a concentration device, not shown, from whence it returns by pipe K. The proportion of the liquid



passed to the concentrator may be controlled by a concentration-sensing device in the sump. It will be seen that the air passing through the apparatus is simultaneously brought to a condition of temperature and humidity determined by the temperature of the cooling fluid and the concentration of the hygroscopic liquid, respectively, supplied to the apparatus, while the electric field eliminates suspended particles and causes any of the deliquescent liquid overflowing the upper ends of the conduits, which may be entrained by the air, to be precipitated on the inner surface of the conduits to form a film or layer offering an extended surface of contact to the air. The air leaving the apparatus is thus cleaned and purified and brought to predetermined conditions of temperature and humidity.—*August 30th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Civil Engineers

Tuesday, Nov. 21st.—Great George Street, Westminster, S.W.1. Ordinary meeting for the election of new members. 3 p.m.

Institution of Electrical Engineers

Saturday, Nov. 18th.—N. Midland Centre. Hotel Metropole, Leeds. "Electrically Manufactured Steels," H. A. Sieveking. 2 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, November 21st.—39, Elmbank Crescent, Glasgow. "Characteristics of Silent Propellers," A. W. Davis. 6.30 p.m.

Iron and Steel Institute

Thursday, Nov. 23rd.—4, Grosvenor Gardens, S.W.1. Statutory Autumn Meeting. 3.30 p.m.

Institution of Production Engineers

To-day, Nov. 17th.—Dorchester Hotel, London, W.1. Luncheon.

Saturday, Nov. 18th.—Yorkshire Section. Hotel Metropole, Leeds. "The Latest Development in Cast Iron Research," A. N. Smith. 2.30 p.m.

Friday, Nov. 24th.—London Graduate Section. Mostyn Hotel, Portman Square, W.1. "Production Control for Widely Varying Products," A. E. N. Bolton. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Nov. 24th.—39, Victoria Street, Westminster, S.W.1. "The Revival of the Gas Producer," K. W. Willans. 6.30 p.m.

Friday, Nov. 24th.—Mining Institute, Newcastle-upon-Tyne. "Aeronautics and Ship Design," J. Lockwood Taylor. 6 p.m.

Royal Institution of Great Britain

To-day, Nov. 17th.—21, Albemarle Street, W.1. "Infra-Red Spectra," W. H. J. Childs and H. A. Jahn. 2.30 p.m.

Sheffield Metallurgical Association

Tuesday, Nov. 21st.—198, West Street, Sheffield. "The Work of the Oxygen Panel," T. Swinden. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

MR. C. W. W. TORRANCE has been appointed to succeed Mr. A. Scott as manager of the Ediswan Belfast Office.

MR. R. B. POTTER has been appointed chairman of Simon-Carves, Ltd., Engineers, of Cheadle Heath, Stockport. Mr. Potter joined the staff of Simon-Carves, Ltd., in 1921, became a director in 1931, and was appointed vice-chairman of the Company in 1937.

MR. MAURICE PATTON has accepted an appointment with Simon-Carves, Ltd., as Sales Manager for Great Britain in the firm's Water Tube Boiler Department, and on November 1st opened a London Office at Bush House, London, W.C.2. Mr. Patton, since 1919, represented the Underfeed Stoker Company in South Wales, and 6 years ago became the sales representative in London and the South of England for International Combustion, Ltd.